REPORT OF PROCEEDINGS

OF THE

FOURTEENTH ANNUAL CONVENTION

OF THE

AMERICAN RAILWAY Master Mechanics' ASSOCIATION,

HELD IN THE CITY OF PROVIDENCE, R. I.,

June 14th, 15th and 16th, 1881.

CINCINNATI:
WILSTACH, BALDWIN & CO., RAILWAY PRINTERS,
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AMERICAN RAILWAY

MASTER MECHANICS' ASSOCIATION.

OFFICERS FOR 1881.

PRESIDENT:

J. N. LAUDER, of Concord, New Hampshire.

FIRST VICE-PRESIDENT:

REUBEN WELLS, of Louisville, Ky.

SECOND VICE-PRESIDENT:

JAS. SEDGLEY, of Cleveland, O

TREASURER:

S. J. HAYES, of Chicago, Ill.

SECRETARY:

J. H. SETCHEL, of Cincinnati, Ohio.

Transp.

REPORT.

The Fourteenth Annual Convention of the American Railway Master Mechanics' Association was held in the Franklin Lyceum Hall, in the city of Providence, R. I., on the 14th, 15th, and 16th of June, 1881.

The Convention was called to order by the President, J. N. LAUDER, of Concord, N. H., who requested the Rev. Augustus Woodbury to offer prayer.

PRAYER OF REV. AUGUSTUS WOODBURY.

OUR HEAVENLY FATHER, who art the Giver to us of every good and perfect gift, in whose hands we always are, and whose presence is our perpetual blessing and support, we desire to thank Thee at this time for Thy great kindness unto us; for thy mercies, which are new every morning and fresh every evening, and renewed through every moment of our lives. We thank Thee for the strength which Thou dost give to us for the performance of our daily labors, for the consciousness of security with which we take our nightly rest, for the guidance of Thy wisdom in all the affairs of life. We thank Thee for the facilities of communication which bring the ends of the earth together, and make more close and strong the ties of human brotherhood, teaching us that we are all members of the same great family of which Thou art the Father, our Father and our God.

As we come together at this time, we pray that Thy blessing may be with these Thy servants, who have assembled here for the purpose of considering together the needs of their respective labors, and the business which Thou dost give to them with increased improvement, and for all those things which belong unto their familiar work. We thank Thee that Thou has brought them here in safety, in mercy and in peace, and we pray that Thou wilt be with them in their deliber-

ations, that all things may be done decently and in order; that their affairs may be guided with discretion, and that the results of this meeting shall be for their own improvement, and for the good of the community. Help them, we pray Thee, while they shall be here, and when they go away from this place, may Thy presence be their safeguard and support in all the affairs of life; and be with those whom they have left in their homes behind them, that they may be preserved during their absence, and may Thy love and kindness and mercy especially be round about them evermore.

We pray that Thou wilt be with all Thy children everywhere, the poor, the weak, the destitute, the afflicted, the captive. We pray Thee to be with all who are engaged in labors for the improvement of human kind. We pray that Thou wilt lead us all in that way which shall be filled with blessing to us here, and with the promise of blessedness hereafter; and grant, heavenly Father, when we have done with these earthly labors, that we may enter into heavenly rest through Jesus Christ our Lord.

Our Father who art in heaven, hallowed be Thy name. Thy kingdom come: Thy will be done in earth, as it is in heaven: Be with us, and strengthen and keep us; deliver us from all evil, and bring us all unto Thyself that we may praise Thy name forevermore. *Amen.*

The President then introduced Hon. William H. Hayward, Mayor of the city of Providence, who delivered the following

ADDRESS OF WELCOME.

Mr. President and Gentlemen of the American Railway Master Mechanics' Association :

As the representative of a community devoted largely to mechanical and manufacturing pursuits, it gives me great pleasure to welcome you to our city. You have come from almost every State in the Union, and the object of your assemblage, as I have been informed, is for the purpose of exchanging information and the comparing of ideas and knowledge obtained during the year's experience as railway Master Mechanics, with a view to the security of life and property, and thus while advancing the interests of the great companies you represent, you are forwarding the material interests and commercial prosperity of our whole people.

The city to which you have come relies for its prosperity, as all great cities rely, upon its facilities of communication with all parts of the world; it also relies upon other mechanic arts than those your Association represents, but akin to them, in that it supplies that which renders the building of railroads not only necessary but profitable. In the magnitude and variety of our manufacturing industries, we take a just pride, and I am confident that you will feel amply compensated for the time spent in a visit to our large establishments.

Again, gentlemen, permit me to welcome you, and to express the hope that you may find your visit here both profitable and pleasant, and that you may leave our borders with the conviction that your time has not been mispent, but that something has been added to the great amount and variety of information that has produced the great results that we see about us in the vast net-work of railroads that has bound together the different parts of our great country, uniting the East with the West and the North with the South, carrying civilization and wealth to the remotest bounds.

I venture to hope that you will have no cause to regret having "put your trust in Providence," and that on some future occasion you will again select our city as a place of your meeting.

THE PRESIDENT. The Secretary will now call the roll of members.

The Secretary then called the roll, and the following members responded:

LIST OF MEMBERS PRESENT.

NAME.	ROAD.	ADDRESS.
ANDERSON, J. H	New York, Providence & Boston	Providence, R. I.
BOON, J. M	Pittsburgh, Fort Wayne & Chicago	Fort Wayne, Ind.
BUSHNELL, R. W	Burlington, Cedar Rapids & Northern	Cedar Rapids, Ia.
BOYDEN, G. E	New York & New England	Boston, Mass.
BROOKS, H. G	Brooks Locomotive Works	Dunkirk, N. Y.
BLACK, JOHN	Dayton & Michigan	Lima, Ohio.
BRIGGS, R. H	Mobile & Ohio	Whistler, Ala.
CUMMINGS, S. M		Boston, Mass.
COOLIDGE, G. A	Fitchburg	Charlestown, Mass.
CORY, CHAS. H	Scioto Valley	Portsmouth, Ohio.
COLBURN, RICHARD	Norwich & Worcester	Norwich, Conn.
COOK, JOHN S	Georgia	Augusta, Ga.

Name.	Road.	Address
COOK, ALLEN	Chicago & Eastern Illinois	Danville, Ill.
DEVINE, J. F.	Wilmington & Weldon	Wilmington, N. C.
ELLIOTT, HENRY		East St. Louis, Ill.
ECKFORD, JAMES	Cincinnati, Hamilton & Dayton	Cincinnati, Ohio.
FLYNN, J. H	Western & Atlantic	Atlanta, Ga.
FULLER, WILLIAM	New York, Pennsylvania & Ohio	Cleveland, Ohio.
FOSTER, W. A	W. & M. Division Fitchburg	Fitchburg, Mass.
GORDON, H. D	Philadelphia, Wilmington & Baltimore	Wilmington, Del.
GORDON, JAMES T	Concord	Concord, N. H.
HAYES, S. J	Illinois Central	Chicago, Ill.
HAM, C. T	Buffalo Steam Gauge Co	Rochester, N. Y.
HEWITT, JOHN	Missouri Pacific	St. Louis, Mo.
HAGGETT, J. C	Dunkirk, Allegheny Valley & Pittsburgh	Dunkirk, N. Y.
LAUDER, J. N	Northern	Concord, N. H.
LEECH, H. L	Hinkley Locomotive Works	Boston, Mass.
LANNON, WM	House Representatives	Washington, D. C.
McCRUM, J. S	Missouri River, Fort Scott & Gulf	Kansas City, Mo.
PENDLETON, M	Seaboard & Roanoke	Portsmouth, Va.
PERRIN, P. J	Taunton Locomotive Works	Taunton, Mass.
PHILBRICK, J. W	Maine Central	Waterville, Me.
PLACE, T. W	Illinois Central	Waterloo, Iowa.
PATTERSON, J. S	Cincin'ti, Ind'polis, St. Louis & Chicago	Cincinnati, Ohio.
RICHARDS, GEORGE	Boston & Providence	Boston, Mass.
ROBB, W. D	Louisville, Paducah & South-Western	Elizabethtown, Ky.
REYNOLDS, G. W	Northern Division Old Colony	Taunton, Mass.
SCHAEFFER, AUGUST	Louisville, Cincinnati & Lexington	Louisville, Ky.
SMITH, W. T	Philadelphia & Erie	Erie, Pa.
SETCHEL, J. H	Little Miami	Cincinnati, Ohio.
SEDGLEY, JAMES	Lake Shore & Michigan Southern	Cleveland, Ohio.
SANBORN, A. J	Indianapolis & St. Louis	Mattoon, Ill.
TAYLOR, J. K	Old Colony	Boston, Mass.
WIGGINS, J. E	Houston, East & West Texas	Houston, Texas.
WOODCOCK, W	Central of New Jersey	Elizabethport, N. J.
WILDER, F. M	New York, Lake Erie & Western	Susquehanna, Pa.
WIGHTMAN, D. A	Pittsburgh Locomotive Works	Pittsburgh, Pa.
WHEELOCK, JEROME	Associate Member	Worcester, Mass.

The Secretary read Article 4 of the Constitution, after which the President announced a recess to enable any persons qualified to join the Association who might desire to do so. The following names were added to the roll of members:

LIST OF NEW MEMBERS.

NAME.	ROAD.	ADDRESS.
EASTMAN, A. G	South-Eastern	Richford, Vt.
ENNIS, W. C	Midland of New Jersey	Wortendyke, N. J.
HOWSON, N. W	Cumberland & Pennsylvania	Mt. Savage, Md.
HOLLISTER, JAMES D	Savannah, Florida & Western	Savannah, Ga.
KENT, WILLIAM	Mechanical Engineer	Pittsburgh, Pa.
LEVIS, J. M	Selma & Greensboro	Marion, Ala.
MINSHALL, E	New York & Oswego Midland	Middletown, N, Y.
STONE, HENRY B	Chicago, Burlington & Quincy	Aurora, Ill.

Upon the Convention being called to order, the President, Mr. James N. Lauder, delivered his Annual Address, as follows:

PRESIDENT'S ADDRESS.

GENTLEMEN OF THE AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION:

It gives me unqualified pleasure to greet so large a number of members at the opening of this, our Fourteenth Annual Convention, and to have your continued interest in our organization signified by your presence, for our experience shows that the time here spent in comparing notes and interchanging views is of real value in indicating the best manner in which to meet the requirements and advance the interests of those whom we serve.

The period during which this Association has been in existence has been one of great importance to the railway interests of the country, and I think we can, with fairness, claim for this body a goodly portion of credit for the present prosperity of our general railway system. It is certain that but for the improved methods introduced in consequence of suggestions emanating from our own and kindred bodies the present rates of transportation would be impossible without doing business at a loss; and, as a result, we are enabled to transport freights from the grain fields of the far North-West, two thousand miles from tide-water, and supply the markets of Europe with bread-

stuffs at a profit to the producer, and a reasonable cost to the consumer. Many changes and improvements have contributed to this result, a part of which can be directly traced to the investigations inaugurated at our Annual Conventions. The introduction and use of steel for rails, locomotive tires, and boilers, has effected much toward solving the problem of "cheap transportation," and it will be remembered that this subject received our earnest attention in the early days of our organization, and our conclusions have been fully sustained by subsequent events.

Steel rails have enabled us to use large locomotives and heavier and stronger cars, so that car-loads have been doubled in weight, and the cost of operating largely reduced, especially in the freight traffic department. Steel tires have also done their part in promoting economy and safety in railway management.

It has been practically demonstrated that steel tires properly secured to the wheels of a locomotive are almost absolutely safe; and the few breakages that do occur can generally be traced to faulty workmanship, and almost exclusively to excessive shrinkage.

The question of the superiority of steel to iron for the tires of driving-wheels for locomotives we may now consider as settled; and yet in the infancy of our Association it will be remembered that committees were appointed who gave the matter the fullest investigation in its then undetermined state, and the discussions elicited may be turned to with an interest greatly enhanced by the marked advance of the past few years.

The displacement of iron and copper for locomotive boilers, and the introduction of steel, was only effected after the most painstaking investigation and repeated experiments; and manufacturers, awakened by the agitation to its importance, have, aided by scientific research, until they have succeeded in producing a steel that is universally admitted to be far preferable to any other material for this purpose; as a consequence, locomotive boiler explosions are now almost unknown, whereas, formerly, they were of comparatively frequent occurrence.

Another outgrowth of our inquiries and examinations has been the steady increase of the locomotive engine in size and capacity. At the time of our organization, only thirteen years since, the recognized standard engine had cylinders 16 by 24 inches, four coupled driving-wheels, with a weight of about thirty tons, and from this the

standard has been enlarged until we now have cylinders of twenty by twenty-six inches, eight coupled driving-wheels, with a weight of fifty tons; and these magnificent machines are now in use in all parts of the country where there are heavy grades to overcome for a large traffic.

The rapid and constant improvement in this respect has been so marked that we may confidently expect still further progress in the future, and it will be our mission, as in the past, to assist this development by continued research, and thus add to the welfare of our immense and unparalleled railway system.

The prosperity which now attends us is a matter for congratulation, and yet we have been taught valuable lessons by the "hard times" which have been experienced during the last decade of years. Perhaps not otherwise would economical methods have received so powerful an impetus, and been fostered by such careful and anxious attention. Let us hope that the habits of frugality and thrift thus established may not be disturbed by the spirit of speculation, which is again making itself felt in the business world. A continuance of our discussions, with the same disposition toward mutual assistance which has always characterized them, will encourage and perpetuate the ideas of retrenchment upon which so much of our prosperity depends, and this without regard to the methods by which the various subjects are presented for our consideration.

The system inaugurated at our last meeting, in Cleveland, promises excellent results, and the reports of the Committees of Research, appointed at that time, will be presented during our present session. Additional papers have also been prepared by three of our Associate Members, and from the well-known ability of the authors will, undoubtedly, add much to the value and interest of our Annual Report.

During the past year two of our members, Mr. John Swift, of the Schenectady Locomotive Works, and Mr. B. J. Gregg, of the Cincinnati, Sandusky & Cleveland Railroad, have been removed by death. They were kind friends, genial companions, and valuable members. I trust suitable action will be taken by this body to testify their appreciation of their worth.

Our Constitution provides for the holding of our Annual Convention on the second Tuesday of May, but for good, and as it was thought, sufficient reasons the Supervisory Committee arranged for its postponement this year until the present time. I trust this action

will meet your approval, and I would suggest the propriety of changing the time for the Annual Meeting if it shall be thought desirable. For the second time you have honored New England by holding your Annual Convention within her limits, and, as a New Englander, I bid you a hearty welcome to our good city of Providence. Although we have representatives here from the icy North, the boundless West, and the sunny South, our interests are identical; and allow me to hope that this assemblage upon the beautiful shores of Narragansett Bay, for the comparison of notes and interchange of ideas, may prove both interesting and profitable.

Upon this gathering probaby depends the future of our Association; and in view of the much that has been accomplished by it, let us unite in renewed and earnest endeavor to continue on our work so as to insure permanent benefit to every member of our profession, and so shall our Association be not only the pride of its members, but shall be honored by every corporation in whose interests our labors are exerted; and, permit me to hope, that so pronounced will be the success of our present session, that, upon its conclusion, you may each and every one feel that you have been amply repaid for all the trouble and expense incident to your attendance upon the Fourteenth Annual Convention of the American Railway Master Mechanics' Association.

Mr. Setchel then presented

THE SECRETARY'S REPORT.

To the American Railway Master Mechanics' Association:

GENTLEMEN—Herewith please find a detailed statement of the membership, financial condition, and such other matters as pertain to the office of Secretary, for the year ending with the Fourteenth Annual Meeting.

Since last report the following persons have become members of the Association: George Hackney, C. Hackney, H. D. Gordon, J. Ivanson, A. R. McAlpine, Charles T. Parry, G. W. Prescott, Thos. W. Ranson, Robert B. Small, B. J. Sitton, Wm. Swantson, W. Spittle, T. B. Twombly, George C. Watrous, George W. West, Thomas West, and John W. Wright, making a total addition of seventeen. Three delinquents having paid up back dues have been reinstated, and two members—Mr. Wilson Eddy, for a long time an earnest, active member, and Mr. W. B. Bement, an Associate Member—have

resigned, and the loss of two members by death, makes the present total membership 195, or an increase of sixteen over last year.

Twelve hundred copies of the Thirteenth Annual Report have been printed, and a copy sent to each member. Two hundred and seventy-four copies have been sent to Locomotive Works and Railroad Companies contributing to our printing fund, and the number furnished in these cases has been limited only by the number asked for, varying from one to fifty copies each. Total number remaining on hand is six hundred and fifty.

The following is a statement of the receipts during the past year from railroads, locomotive works, and others, to the printing fund:

NAMES OF CONTRIBUTORS TO THE PRINTING FUND.

Cleveland, Tuscarawas Valley & Wheeling Railroad	$20 00
Chillan, Concepcion & Talcahuano Railroad	10 00
W. W. Evans, Associate Member	10 00
Philadelphia, Wilmington & Baltimore Railroad	10 00
Schenectady Locomotive Works	10 00
Brooks Locomotive Works	10 00
Boston & Providence Railroad	10 00
Pittsburgh Locomotive Works	15 00
Connecticut River Railroad	10 00
Illinois Central Railroad	10 00
H. K. Porter & Co	8 00
Missouri Pacific Railroad	10 00
Flint & Pere Marquette Railroad	10 00
Jeffersonville, Madison & Indianapolis Railroad	10 00
Delaware, Lackawana & Western Railroad	10 00
Chicago & Eastern Illinois Railroad	10 00
Delaware & Hudson Canal Co	10 00
New York, Lake Erie & Western Railroad	10 00
Lehigh Valley Railroad	10 00
Grand Trunk Railroad	10 00
Concord Railroad	10 00
Louisville, Cincinnati & Lexington Railroad	10 00
Baldwin Locomotive Works	10 00
Northern Pacific Railroad	10 00
Lake Shore & Michigan Southern Railroad	10 00
Cleveland & Pittsburgh Railroad	10 00
Rogers Locomotive Works	10 00
Central Vermont	10 00
Amount forward	$293 00

Amount forward	$293 00
Selma, Rome & Dalton	10 00
Pittsburgh, Cincinnati, St. Louis (2d and 3d Div.)	10 00
Pittsburgh, Fort Wayne & Chicago	10 00
Mobile & Ohio	10 00
New York, Pennsylvania & Ohio	10 00
Canada Southern	10 00
Cincinnati, Hamilton & Dayton	10 00
Northern	10 00
Louisville and Nashville	12 00
Old Colony	10 00
Burlington, Cedar Rapids & Iowa	10 00
Total amount, Printing Fund	$405 00
Amount received for Railroad Gazette for use of MS	50 00
Reports sold by Railroad Gazette	25 20
One set of Reports to England	16 50
Five Reports sold to George Hubby	7 50
Four Reports sold to Atlantic Works	6 00
One Report sold to Frank C. Smith	1 50
One Report sold to ——— ———	1 50
Receipts from members, assessment dues	811 00
Making total amount received	$1,324 20

For which I hold the Treasurer's receipts.

THE BOSTON FUND,

Consisting of thirty-seven hundred Four Per Cent Bonds, with accrued interest, amounts as follows:

Interest and amount unapplied up to date, last report		$153 31
July interest,	1880	37 00
October "	1880	37 00
January "	1881	37 00
April "	1881	37 00
Total interest		$301 31

Which amount, added to the principal, shows the present value of the original Boston Fund, $4,001 31.

In this connection the following letter will be interesting, and explains itself:

CLEVELAND, O., June 23, 1880.

J. H. SETCHEL, ESQ., *Secretary Master Mechanics' Association, Cincinnati, O.:*

DEAR SIR—Enclosed please find my exchange for $68.20, which please accept, with the compliments of the business men of this city. This amount

was what the Committee on Entertainment had left over after defraying expenses of entertaining the Convention at this point.

Very respectfully,

GEO. W. BILLINGS, Jr., for Committee.

This correspondence was at once referred to President Lauder, who directed its acceptance and incorporation in the Boston Fund. This amount, added to the interest above shown, gives a total uninvested of $369.51, and increases the grand total to $4,069.51, not including the premium. For the correctness of this statement you are respectfully referred to the Treasurer, S. J. Hayes, who kindly came from Chicago, and with your Secretary made a careful examination of this fund.

All of which is respectfully submitted,

J. H. SETCHEL, *Secretary.*

On motion, the Secretary's report was accepted, after which the Treasurer's report was submitted, as follows:

TREASURER'S REPORT.

S. J. HAYES, *Treasurer*, PROVIDENCE, R.I., June 14th, 1881.

In account with

THE AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION.

1880		DR.	1880		CR.
May 13	To Balance on hand	$641 42	May 13	Voucher No. 1, J. H. Setchel, Secretary......	$600 00
May 13	" Cash from Secretary......	275 00	May 13	" " 2, A. Smith, Janitor..............	3 00
Oct. 4	" Dues from E. T. Jeffery	5 00	May 13	" " 3, Vincent, Sturm & Barstow ..	9 75
			August 4	" " 4, T. W. Minton......................	100 00
1881			1881		
March 26	To Cash from Secretary.....	15 00	March 26	" " 5, Cincinnati Safe Deposit Co.	15 00
March 26	" "	459 75	March 26	" " 6, Wilstach, Baldwin & Co. ...	459 75
May 21	" "	532 25	May 21	" " 7, Cincinnati Safe Deposit Co.	15 00
June 13	" "	37 20	May 21	" " 8, Postage	32 25
				To Balance	730 87
		$1,965 62			$1,965 62

Respectfully submitted, S. J. HAYES, *Treasurer*.

THE PRESIDENT—We have a communication prepared by the Supervisory Committee, which it has been thought best to present to the Association at this time, in regard to the action of the Supervisory Committee in changing the time of meeting from May 10th to June 14th, giving the reasons therefor. The Secretary will please read it.

The Secretary read the communication, as follows:

Report of the Supervisory Committee.

To the American Railway Master Mechanics' Association:

GENTLEMEN—Your General Supervisory Committee would herewith respectfully submit their reasons for the postponement of the Annual Meeting until this time. On the 26th of March the Secretary received a letter from a Western member of the Supervisory Committee asking if the Convention could not be postponed one month, saying he thought it should be for the same reasons for which it was postponed in 1872, when we met at Boston. It will be remembered that then, out of a vote of 131 members, 125 were in favor of the change. The almost unanimous vote at that time seemed a clear indication that a postponement at this time would meet with a like hearty indorsement, for the same reasons making it desirable, existed in double degree.

The Convention now, as then, was appointed for May 11th, which date was considered too early in the month for members to finish up their monthly work and be able to reach Providence at that date. The Western roads were blocked with snow, and Master Mechanics were straining every nerve to get through the winter with their machinery in the best possible condition, and it was doubtful with many if they would be able to attend the Convention at all. The month of May, like the day of the month, came too early for the Western members, and they asked for a change. The proof sheets of circucular of the Committee of Arrangements for the meeting were on the Secretary's desk, and if any thing was to be done it must be done quickly. The telegraph was brought into service, and the opinion was at once made unanimous to change the time to June 14th, which date was selected because it seemed the most favorable time in the month for members to leave home, the 7th being too early, and the 18th too late; and as it has proved in several cases the arrangement has been undoubtedly beneficial to the best interests of the Association. The fact that the Car Builders' Meeting would occur on the same day was not thought of at the time, and not until all the arrange-

ments had been made for the present meeting. This much is due by way of explanation, and the General Supervisory Committee are confident their course will be approved by the Association.

THE PRESIDENT—Gentlemen, you have heard the statement of the Supervisory Committee read; I do not know that any action is necessary to be taken in the matter, but the Supervisory Committee would, I presume, like to have their action indorsed by the Association, and I will await any motion.

On motion, it was voted that the communication of the Supervisory Committee be received and indorsed.

THE PRESIDENT—It is usual, at this time, to appoint a Committee on Finance, whose duty it shall be to audit the accounts of the Secretary and Treasurer, and recommend to the Association the amount of assessment necessary for the coming year. I will await a motion on this matter.

On motion of Mr. S. J. Hayes, it was voted that there be appointed a Committee on Finance and a Committee on Correspondence.

The President appointed the following named gentlemen as the Committee on Finance: George Richards, of the Boston & Providence Railroad; William Woodcock, of the Central Railroad, New Jersey; James T. Gordon, of the Concord Railroad, New Hampshire.

The following-named gentlemen were appointed as the Committee on Correspondence: John Black, of the Dayton & Michigan Railroad, Ohio; S. J. Hayes, of the Illinois Central Railroad, Illinois; Frank M. Wilder, of the New York, Lake Erie & Western Railroad, Pennsylvania.

Mr. Wilder declined to serve on account of his inability to be present, and the President appointed instead Mr. J. H. Flynn, of the Western & Atlantic Railroad, Georgia.

THE PRESIDENT—The next business, gentlemen, to come before the Association is the report of your Committee of Research on Improvements in Boiler Construction. I understand from the Secretary that there are several reports by different members of the committee in his hands, which he will please read.

The Secretary then read the following report from the Chairman of the Committee, Mr. Reuben Wells, of the Louisville & Nashville Railroad.

Report of Committee of Research on Improvements in Boiler Construction.

To the American Railway Master Mechanics' Association:

GENTLEMEN—Your Committee on Boiler Construction and Improvement, appointed at your last Annual Convention, after an interchange of opinion on the subject, concluded that each member of the committee should make an independent report to the Convention on

some branch of the subject assigned us for investigation, if circumstances should permit it, and that we would not undertake to make up a report embracing in one all that might be offered on the subject, but leave each member of the Committee free to select his own subject for investigation, collect his facts, and make his report to the Convention. So far as the Chairman of your Committee was concerned no other course was practicable. The demands of business were such that time could not be spared to collect the data for a full report, and no other member of the Committee seemed willing to assume the task, not having the time at command necessary to do the work.

A branch of the subject of boiler construction worthy of some further investigation, it seems to me, is that of "set riveting," commonly called button-set riveting, in distinguishing it from hand riveting, as generally practiced in riveting boilers.

The idea usually conveyed by the term button-set riveting is the plan of forming the head of the rivet to the shape of a half globe, by placing on the end of the heated rivet a set, with a rounded cavity, and driving it down with a sledge, at the same time slightly moving the set from side to side, to round down the lower edge of the head to properly finish it. This plan has generally been regarded with disfavor, and has heretofore been but little used in riveting the seams of boilers where tight work was required.

A plan similar to this has been practiced for several years by the Louisville & Nashville, and, perhaps, other roads, in the construction of locomotive boilers, which, at least, so far as the Louisville & Nashville Road is concerned, has been so eminently satisfactory in all respects, that a detailed description of the plan, and the tools used will perhaps be considered worthy of your consideration.

The object to be accomplished in riveting is to cause the rivet to perfectly fill the hole, and, at the same time, draw the plates perfectly tight together. The steam-riveting machine undoubtedly best fulfills these conditious in its work; but all riveting can not be done by steam riveters.

The steam-riveting machines are expensive in their first cost, and it is only where a large amount of work is to be done that the advantages derived will justify the outlay in capital. Smaller, and what may be called portable steam-riveting machines, have lately been brought to the notice of the public, but it is questionable whether,

for locomotive boiler work, they will prove a success. As before stated, it is only in cases where a large amount of riveting is done that the advantages of the steam riveters will warrant their cost, and a very large proportion of boiler riveting must therefore be done by hand, or some plan requiring a comparatively small outlay for tools.

The plan of set riveting consists of nothing more or less than placing a set on the end of the rivet, having a conical shaped cavity, of the shape and size of the finished rivet head; holding it square, and driving this set down on to the rivet, forcing the rivet against the holder and swelling it until the hole is perfectly filled and the head formed and plates drawn tightly together.

The manner of driving rivets by this plan is illustrated in Fig. 1, which shows the position of the set as held on the end of the rivet while being driven down with the sledges to form the head.

The weight of the set is from two and a-half to three pounds, and of the holder about sixty pounds, and of the sledges nine or ten pounds each.

The size of the conical cavity in the set for forming the head on a $\frac{3}{4}$ inch rivet is $1\frac{5}{16}$ inches in diameter at the base, and $\frac{3}{4}$ inches deep, which forms a head as represented in Fig. 2.

The length of the rivet should be so proportioned that, when driven, the lower edge of the set will about touch the sheet, so as to leave no surplus iron at the base of the head, at the same time the body of the rivet filling the hole and the head being perfectly formed and full size.

In driving rivets by this plan no skilled labor is required other than knowing how to place the holder tightly on the rivet when put in the hole, and holding the set squarely on the end of the rivet, and sledging it down to form the head; the operation requiring two men to sledge—one to hold the set, one to manage the holder, and a boy to heat the rivets. The rivet is not struck direct by the sledges at any time during the operation of driving, but the head is formed entirely by driving the set down squarely on the end of it. To drive a rivet requires about twenty-four blows with the nine or ten-pound sledges, given at the rate of about eighty blows per minute. A flatter, with a face about $1\frac{1}{2}$ inches square, is then placed on the lap alongside the rivet, and given five or six blows to close the sheets

together; the set is then placed on the rivet head again, and given five or six more blows, and the rivet is finished; the whole operation of driving requiring about thirty-five seconds of time to the rivet.

In practice we find that a riveting gang will drive in the seams of the shell of a boiler an average of 30 rivets per hour, or 300 per day, and in the seams of the fire box, in throat and back sheets, dome, mud ring, braces, etc., an average of about 22 rivets per hour. This includes the time necessary for taking out bolts, drifting holes, adjusting the tools and the work.

In hand riveting we find that two riveters will drive, on an average, taking the whole boiler, only about 125 rivets per day, or $12\frac{1}{2}$ per hour.

At these rates of driving rivets by the two different methods, the difference in the cost of driving the rivets in one of the standard boilers of the Louisville & Nashville Railroad Company, for an 18 by 24 inch cylinder engine, and the time required to do the work, would be as follows, the boiler being double-seamed in all transverse seams, and "welt seams" in all longitudinal seams, the number of rivets in the boiler being as follows:

Rivets in the fire box seams	258
" " mud ring, long rivets	94
" " smoke box, long rivets	32
" " dome ring, long rivets	38
" " dome flanges	69
" " dome vertical seam	12
" " front flue sheet	62
" " back seam of smoke box	32
" " connection, rib braces	40
" " vertical braces in dome	18
" " angle-iron bracing	30
" " angle-iron bracing, back head	28
" " angle-iron bracing, front head	31
" " long braces to barrel	36
	780

This would make the cost of driving the rivets for the whole boiler amount to \$98.81, or an average of 5.84 cents per rivet, and require a little more than 13½ days' time to do the work; as against \$44.77, and a fraction more than 6½ days' time to perform the labor by the set-riveting plan; a difference in favor of the latter of 54 per cent. in cost and 51 per cent. in time.

In the case of hand riveting, where but little time is lost in moving the work, and adjusting tools, taking out bolts, etc., as many as sixteen or eighteen rivets can be driven per hour; but taking the whole boiler, and the occasional delays in moving the work, the average will be about as stated above.

In like manner, in set riveting, more than 30 rivets can be driven per hour without difficulty, when no unusual time is lost in adjusting tools and the work, but the average will be about as I have given it.

In set riveting the comparatively deep conical cavity in the set prevents the end of the rivet from swelling out, or spreading, as it otherwise would, if driven with the face of the hammer, and in consequence it is driven well down into the hole until it is perfectly filled, or as nearly so as it is possible to cause a rivet to do that is hotter when driven than the metal in the plates. Driving with set and sledges the rivet need not be quite so hot as in case of hand driving, and consequently it will fill the hole more perfectly when cold; also, in driving the rivet, the force of the blows given is in exactly the proper direction to accomplish the object of forcing the rivet down and swelling it until the hole is perfectly filled and plates closed together; while, in the case of hand riveting, after striking the rivet a few blows squarely on the end with the riveting hammers, the direction, or force of the blow, is changed to an angle from the center line of the rivet; and instead of being in the direction to drive the metal solidly into the hole, it is slightly in the direction to drive the rivet from one side to the other in the hole as indicated by the dotted lines in Fig. 3.

This is more particularly the case when the rivet heads are sharply pointed. In driving rivets by hand, the weight of the hammers is only about three, or three and one-half pounds, and it is with their comparatively light blows that the metal of the rivet is expected to

be forced down into the hole so as to perfectly fill it. Whether this expectation is realized in a majority of cases, or not, may easily be determined by planing a seam through the center of the rivets. On the other hand, in driving rivets by the set-riveting plan, sledges are used weighing from nine to ten pounds, and the blows are given as hard as men can strike by swinging the sledge overhead, and are given squarely on the end of the rivet; the set preventing the projecting end from spreading until the rivet has filled the hole, and can be forced no further in that direction, then the head is formed as in a mold in the conical cavity of the set, the force of the blows closing the plates solidly together.

As an evidence as to how rivets fill the holes when driven by the different plans referred to, I submit herewith for inspection three specimens which are planed through the center of the rivets, and polished so as to show how the metal in the body of the rivets has been forced into the holes in driving. The one marked A is hand riveted; B was riveted by the set-riveting plan, and C by steam riveting, except the rivet marked D, which was hand driven. The rivets in all of these specimens were driven under the same conditions as occur in riveting up boilers, and may be regarded as fair specimens of the work done by each plan.

Some of the holes in each row were purposely made so that they did not match fairly when the plates were put together, so as to show how the rivet filled a crooked, or offset, hole under the three different plans of driving.

It will be noticed that there is a marked difference in the three different seams as regards the rivets filling the holes. Those driven by the steam riveter filling as perfectly as it is possible to make them; but it is to those driven by hand, and by the set riveting plan, that are more particularly under consideration in this report.

The plates seem to be drawn together equally well in the three different specimens, but the rivets do not fill the holes nearly so well where driven by hand as those driven by the set-riveting plan; in fact, very few of them fill the hole except immediately under the head. On the other hand, those driven by the set plan, in most cases, fill the hole perfectly, and they are a very much better job of riveting than those driven by hand; they are as much better than

hand driven as steam driven are better than those driven by the set-riveting plan.

Neither of the two samples are, perhaps, as good as it is possible to drive the rivets; but, in the usual manner of doing such work, they are fair average specimens of $\frac{3}{4}$ inch rivets driven in plates $\frac{7}{16}$ inches thick. The reason for such conclusion is based on the result of several different tests, the specimens being planed through the center of the rivets, the same as these, in order to see how the holes were filled by the body of the rivet, in the case of each plan of driving them.

A number of steel boilers, in use on the Louisville & Nashville Company's lines, have been made in which the rivets were driven by the set-riveting plan, including those in the fire box, throat sheet, mud ring, dome flanges, braces, etc.; in fact, almost every rivet in the boiler, including the counter-sink rivets, a special shaped set being used however for the latter. These boilers are all perfectly tight, and were so from the first.

Unquestionably, rivets driven by the plan described, fill the holes more perfectly than those driven by hand, and the plates are drawn together equally as well; and from practical experience in the construction of a number of boilers, the cost of labor in driving rivets is found to be only about one-half of that of driving them by hand, and the time required to do the work is also reduced in the same proportion.

Now, if these are the facts, it is difficult to give a reason why hand riveting is so generally practiced where steam riveters are not used, and why set riveting has not heretofore been adopted to a much greater extent if the plan is a better and a cheaper one than the old plan of driving by hand. Set riveting is certainly nothing new under the sun. Experience, however, has demonstrated the fact that skilled labor looks with disfavor upon any plan of doing work whereby unskilled labor is able to accomplish the same thing, equally well, at reduced rates of wages. There is a natural inclination to oppose new ways of doing a thing, especially when it involves to a great extent, at least, the abandonment of a practice followed almost universally in the construction of boilers, until partially superseded by steam riveting within the past fifteen years. Boiler making is carried on mainly by those skilled in the old way of doing work, and it is

not natural that they should desire a different plan, more particularly when it dispenses with what is valuable to them—their skill in driving rivets—and, as a class, they oppose and discourage the plan of driving rivets by a set and sledges. These are, doubtless, some of the reasons why set riveting has not met with greater favor. It seems to me, however, that this plan of set riveting, owing to its cheapness and expedition in doing the work, should receive more attention in the way of carefully made tests as to quality of the work done by it, and the cost for labor, than has heretofore been given to it, and it is with the view of calling attention to the plan that this report has been written.

Steam riveters drive from 30 to 60 rivets per hour, depending on the machine, the character of work, and the way it is managed, and the cost for of the gang driving the rivets, varies accordingly, from $1.\frac{1}{10}$ cents to 3 cents per rivet.

A gang of men, driving rivets by the set-riveting plan, will average about 26 rivets per hour, taking the whole boiler, at a cost for labor of $2.\frac{64}{100}$ cents per rivet; and to drive them by hand, a gang of men will average about $12\frac{1}{2}$ rivets per hour for the whole boiler, at a cost for labor of $5.\frac{84}{100}$ cents per rivet. The figures given as to the work done by steam riveters, and the cost for labor, was furnished by two prominent locomotive building firms as the work done by their machines. *All* the riveting in boilers, however, is not done on their steam riveters, a portion of it is done by hand; therefore, taking the whole boiler into account, the average cost per rivet will be considerably above that of the rivets driven by the machines. The cost of set riveting, as given, is made up from the average day's work in driving rivets in new boilers built, and the cost of hand riveting is that given by those building boilers by that plan of driving rivets, so that the figures given above may be regarded as tolerably accurate in the cost of doing the work by the three different plans of riveting.

Respectfully submitted, R. WELLS, *Chairman of Committee.*

On motion of the Secretary, the foregoing report was received.

THE PRESIDENT—This subject is now open for discussion. It is a very important one, and I hope it will receive such notice as its merits entitle it. I would say that, in my opinion, Mr. Wells has made it very clear that button-set riveting, so-called, may be, and I do not know but he has made it clear, that it *is* superior to hand riveting. If that is the case we cer-

tainly ought to abandon hand riveting immediately. It is a very expensive way of doing that kind of work. I hope this matter will be discussed fully, and the experience of the members given to the Association.

Mr. R. H. BRIGGS, Mobile & Ohio Railroad—Several years ago I was in the Louisville & Nashville shop, and saw this process, and I was favorably impressed with the idea, and concluded that I would try it myself when I returned home. Since that time I have used it altogether, and I find that Mr. Wells' report is exactly in accordance with my own experience; but there is one important item which, if I am not mistaken, he omitted, and that is, the comparative strength of the two kinds of riveting. Our General Manager is a very practical man, and he likes to see things demonstrated, and for that reason I made an experiment to test their relative value. I constructed a small cylindrical boiler, about fourteen inches in diameter and about three feet long, and, for a test, I did one-half the riveting on a horizontal seam by the button set, and the other half by the hand riveting process. I then submitted it to hydraulic pressure, and I found, in every instance, that the head of the hand rivet would come off at a high pressure, and appeared very much crystallized, while the button-set rivets were never moved. I tried that experiment a number of times, and the button-set head remained secure, while the hand-riveted head came off every time. I think that this test brings out one of the most important facts of the whole matter; that is, the button-set riveting is really the stronger of the two. Now, in reference to the trouble and difficulty we have in doing this work, I presume that the gentlemen here present imagine that all of us, away down in our part of the country, are rather inclined to be old fogies. Well, it would look like egotism for me to say we are not; we like to demonstrate things by tests, but one of our difficulties is in getting the men to do the work. It is the hardest matter in the world to get the boiler makers to use the button set. In one instance I had to resort to extreme measures in order to get certain tests carried out; but when they saw I was in earnest I had no trouble. Whenever a new man comes into the shop he has something to say about it, and tries to create dissatisfaction. This method of button-setting rivets I think should receive encouragement from Master Mechanics. It is a great revolution in boiler making.

Mr. A. SCHAEFFER, Louisville, Cincinnati & Lexington Railroad—I was connected with the Louisville & Nashville Road from 1869 to 1878; and in 1874 Mr. John Hebden, the boiler maker, commenced experiments in riveting heads, the result of which was in harmony with Mr. Wells' statement. I fully concur with him in his report on button-set riveting. There is no doubt whatever that the hand riveting is not the most economical and perfect manner to rivet large work. The button-set riveting is giving the best results, which fact is clearly shown in the several specimens sent by Mr. Wells. I think it would be well to make a set of tools, as shown in the full size drawing before you, and to adopt this method of riveting.

Mr. J. H. SETCHEL, Little Miami Railroad—After reading this admirable

report of our worthy first Vice-President, who, by the way, never does any thing by halves, I feel more than pleased with myself for having introduced this question to the Convention last year, that is: Is Button-set Boiler Riveting Practical and Economical? Those of you who were present then know what fierce opposition it encountered. Some of our ablest Master Mechanics in the country cried it down privately, if they did not say any thing against it openly, and some of them denounced it openly, and did not hesitate to say that button-set riveting was a humbug; that it had been tried in England years ago and abandoned. My friend Wells has demonstrated to my mind very clearly that it is not only practicable, but highly economical; and as the gentlemen from the Mobile & Ohio Railroad [Mr. Briggs] has said, it seems to me to be one of the greatest revolutions in boiler making that has been inaugurated for years. Noting the specimens accompanying the report, the seams are equally well drawn together, and the holes are better filled than with the hand-riveting process, there being no difference whatever in the amount of strength applied for drawing the sheets together, the limit being the strength of the rivet. It was admitted at the last Convention if the rivets could be made to fill the holes equally well by this method we would say at once adopt it. Now this illustration shows not only that it can, but that it does, fill the holes much better. Then as to cheapness button-set riveting almost rivals steam riveting. Steam riveting is good, but we can not all have steam riveters, and, if we had them, we could not do all our riveting on our boilers with them. There is always a portion of the work that must be done by hand, and in this hurried age, when every railroad shop is crowded to its utmost to fill orders, we have got to do a great deal of our own work, and I do not know any thing so important for the members of this Convention as to examine this system of riveting presented by Mr. Wells, and go home and quietly adopt it. I know opposition will be met with from a class of men who depend upon their skill in riveting for their position. They dislike to see men come in and do work with little or no skill that they have had to work years to learn. Boiler makers will generally cry it down, and sometimes you may have to resort to harsh means to get them to adopt it, but I believe it will eventually be adopted. I have so much confidence in Mr. Wells' report that I do not believe it can be successfully contradicted; that the plan is practical and economical, and I think the sooner we make up our minds to that, and instruct our boiler makers that this is going to be our practice, the better it will be for the Convention, and it will show to the railroad world we are making rapid strides of improvement, and that the Conventions of Master Mechanics and Master Car Builders are really good things after all.

Mr. BRIGGS, Mobile & Ohio Railroad—I neglected to say in the experiments I used the same brand of rivet every time. I did not use one make of hand rivet and another make of button set, but it was the same in every instance.

Mr. F. M. WILDER, New York, Lake Erie & Western Railroad—I would say that within the last six months in our shop, on the Erie, I have given

orders to use button-set riveting on all our work, except where we do steam riveting, and we are using it right along. We are building about five boilers a month.

Mr. H. L. LEECH, Hinckley Locomotive Works, Boston, Mass.—I think this Association is under great obligations to Mr. Wells for his able report. It seems to me, however, that there is still another principle in that method in addition to what the gentlemen from the Mobile & Ohio [Mr. Briggs] stated; which is, that as the rivet fills the hole it is enlarged, and, consequently, it is not so apt to be cut off by the shearing process as we have sometimes found rivets do in hand riveting.

THE PRESIDENT—Are there any other remarks to be made on this question? It would seem that there is very little chance to get up a discussion, as every one that has tried the button-set process approves of it. For myself I can not say practically that I know any thing about it; but knowing the man who has presented this report, as I do, I have full confidence that that system of riveting is equally as good as the hand riveting, and inasmuch as it is at least 50 per cent. cheaper, I shall certainly adopt it; and if the men I employ do not choose to rivet my boilers as I want them riveted, I shall replace them with others, that is very certain. I do not think we can allow our mechanics in our shops to dictate to us how we shall do our work. There may be times when circumstances force us, in a measure, to accede to their notions; but, I think, the members here will bear me out in saying that those things generally can be got over, and Master Mechanics can have their work done as they want it, because if the men at present employed do not do the work as desired they can be replaced with others that will.

Mr. WILDER, New York, Lake Erie & Western Railroad—I would like to say a word further in this connection. As I said before, we build about five boilers a month. We are doing this with less of what we called skilled mechanics than we had before we made the change, and where we were doing half the work we are doing now with skilled mechanics, we are now doing double the work by a change of methods and with unskilled workmen. I think the consideration of the best method of doing boiler work has been very much neglected while we have been giving our attention to other questions relating to machinery, and how to do machinery work, such as planing, etc. It is a subject that deserves a great deal of attention.

Mr. JOHN BLACK, Lima, Ohio, Dayton & Michigan Railroad—I would like to ask Mr. Wilder if his fire boxes are button-set riveted also?

Mr. WILDER, New York, Lake Erie & Western Railroad—They are. With our button-set riveting we have less leaking, and we have less trouble generally than we had by the hand method. There is also one other thing I would state in regard to improvements in boiler construction. About eight months ago I commenced to use a flexible shaft for tapping and putting in stay bolts, and, I think we make a saving of half the cost over doing it by hand.

Mr. J. S. MCCRUM, Kansas City, Mo., Missouri River, Fort Scott & Gulf Railroad—I think the button-set riveting is superior to the hand riveting,

and I shall go home and endeavor to introduce that system. We may encounter opposition, as has been said, from boiler makers. In fact there are a great many that are skilled mechanics who are not very skillful in the particular direction of this change; and if this is an improvement, as I think it is, such men should not be allowed to prevent its adoption.

On motion of Mr. J. M. Boon, Pittsburgh, Fort Wayne & Chicago Railroad, the discussion of Mr. Wells' paper was closed.

THE PRESIDENT—The next business in order will be the reading of a paper prepared by Jacob Johann, of the Wabash & St. Louis Railroad. Unfortunately Mr. Johann is unable to be here, but his report is in the hands of the Secretary and will be read by him.

The Secretary then read the paper, as follows:

Report of J. Johann on Boilers.

SPRINGFIELD, ILLS., May 15th, 1881.

J. H. SETCHEL, ESQ., *Secretary of the Master Mechanics' Association:*

DEAR SIR—There having been no arrangements made with the Boiler Committee for this year, owing to the pressure of increased business requiring close attention to the duties of their respective departments, I have been requested by Mr. Wells, Chairman of the Committee, to furnish a paper on boiler matters, in order to keep the subject before the Association.

Although having been very busy myself during the past year, and entirely unable to prosecute any experiments, I will endeavor to give a few points on boiler construction that may prove to be of some interest for the discussion of members at the coming meeeting, and which may be considered as a continuation of the paper read by me before the Convention of last year.

As a resume of my paper of last year, it will be remembered that I made mention of two large boilers for 17 by 24 inch cylinder engines that I built for the purpose of determining, by actual experiment, the relative merits between the wagon top and straight-top types of boilers.

For one of these engines I built a wagon-top boiler after the ordinary and generally accepted type, with a straight and level fire-box crown sheet.

For the other I built a straight-top boiler, with arched and sloping crown sheet, and in which the crown sheet is stayed by long and direct stays to the boiler crown.

It was my intention during the past year to have made a series of

extended experiments with the two engines having these boilers, but I am exceedingly sorry to say that the circumstances were such that I was prevented from doing so.

In the wagon-top boiler I used a level and flat crown sheet, as this is the type that is in most general use, but it is however contrary to my usual practice, as I prefer an arched and sloping crown sheet.—[See engraving, Thirteenth Annual Report, page 54.]

Plate 1 will show the arrangement that I have used in wagon-top boilers for a number of years, and in which I slope the crown sheet one inch to the foot, and arch it with a rise of three inches in the center.

As will be seen I have made provision for keeping the crown sheet as open as possible, by only using about twenty ferrules between the crown bars and crown sheets on those along the centers of the bars. By practical experience I have found this number to be amply sufficient.

The method I use for putting in crown bolts is to screw the bolt into the sheet, and use a nut and a diamond-shaped lipped washer on top of crown bar, screwing down the nut until a strain is brought on the sheet, and then riveting the ends of the bolt inside of the crown sheet and over the nut, which arrangement has given good satisfaction.

On Plate 1 you will notice two sections through a crown bar, one showing crown-bar bolt with washer, and the other without washer, which more clearly explains the manner of securing the crown-bar bolt.

As the wagon-top type of boiler is so nearly uniform in construction throughout the United States, I will say nothing further on the subject.

With the straight-top boiler, however, the case is very different; and as the method or supporting the fire-box crown by long stays has created quite considerable interest, I can truthfully say, for the benefit of those who have expressed some doubt as to the stability of this arrangement, that the two boilers having this construction, that were designed and built by me in February and August of 1879, have given perfect and entire satisfaction, the steaming qualities being equal to, if not greater, than in the case of wagon-top boilers.

The engines having these boilers perform their duties in the most satisfactory manner and under the most trying circumstances.

In answer to two other objections that are frequently made against the straight-top boiler, namely:

First. Straight-top boilers will not carry their water as well as wagon-top boilers.

I do not consider this a valid objection, as it has been fully demonstrated in practice that these engines do carry their water equally as well as those having wagon-top boilers, as the engines having these boilers have been pulling our fastest and heaviest passenger trains.

Second. Although the straight-top boiler may be made to do very well on a level road, it will give trouble on a road that has a number of heavy grades.

In answer to this objection I can only say that that portion of the road over which these engines are running have a numbor of grades that are over forty feet to the mile, and some of them of considerable length; and, furthermore, that they have hauled heavy trains over another portion of the road on which the ruling grade is over ninety feet to the mile; but we have experienced no difficulty on this account whatever.

The first one of this type of boiler was built for a 15 by 22 inch cylinder engine, in February, 1879, and from May, 1879, to February, 1881; both inclusive, this engine has made a mileage of 79,570 miles in passenger service, and 4,500 miles in freight and miscellaneous service, being a total of 84,070 miles, or an average of 4,200 miles per month.

During all this period neither the flues or stays gave any trouble or exhibited any signs of leaking.

In February of this year, however, it became necessary to take the engine in shop for a new tire, and in order to more thoroughly inspect the condition of the long crown stays I had the flues removed, and a thorough examination of the crown stays showed that they were all sound and gave no indications of leaking. With the exception of a thin layer of limestone scale, about one-sixteenth of an inch in thickness, the crown sheet and stays were entirely clear. I then had the flues replaced, and the boiler closed, without disturbing a single long stay.

The next boiler of this class that I built was for a 17 by 24 inch cylinder engine, the boiler in this case being much larger—fifty-two inches inside diameter of smallest ring of barrel—and constructed

carry a pressure of 150 pounds per square inch. This engine, ›m October, 1879, to April, 1881, both inclusive, has made a ileage of 69,795 miles in passenger service, and 11,728 miles in eight and miscellaneous service, being a total of 81,523 miles, or an average of 4,300 miles per month.

During this time the long stays have shown no signs of weakness, ›r have they required the expenditure of a single dollar for labor material in repairs to the crown stays.

The expectations under which these boilers were constructed, in eventing sediment from lodging on the crown sheet and impairing : heating capacity, have been more than verified, as it has been ly demonstrated that the crown sheet keeps itself clear from pos- sediment, and that the stays are abundantly sufficient to sustain crown.

his system of staying is not considered as any thing new or l, the chief difference being in the arching and sloping of the n sheet, which, as I have said before, I consider a great advant- over the level and flat system, both in strengthening the crown in preventing the lodgment of sediment.

would like to call attention, however, to another difference which ts in the manner of securing the long stays. My method is to one inch round iron, upset at one end to admit of an inch and -eighth thread. The holes in boiler crown are tapped out to $1\frac{1}{8}$, and in fire-box crown to 1 inch thread, special taps and ream- having been made for the purpose.

The stays are then screwed into place, and cut off within $\frac{3}{16}$ of an h of the inside and outside crowns, and riveted over with a few ll directed blows of the hammer.

A reference to Plate 2 will show more clearly the manner of se- ring these stays.

As a comparison between this and some other methods, Plates 3, and 5 will furnish some examples of European practice.

Plate 3, from the London Engineer, of March 4th, 1881, page 9, gives an adaptation of the well known European Belpaire sys- m to a locomotive built in England for the Holland State Railway. In this system both the fire box and boiler crowns are flat and vel, and the stays are secured by means of nuts on the outside of ›iler crown, and on the outside and inside of fire-box crown. The aking of the boiler crown flat necessitates an increased amount

of transverse and longitudinal staying, and this, with the other objections to flat and level crown sheets previously enumerated, prevents me from agreeing with our English friends when they say that this is the only correct shape for direct staying.

One of the objections the English find with direct staying, as represented by the Belpaire system, is that they prevent the free upward expansion of the fire box, thereby crushing the flue sheet and rendering the top two or three rows of flues more or less oval in shape where they enter the flue sheet. I account for this, however, by the persistence with which they retain the use of copper in fire boxes, and in the using of a large number of flues, necessitating the making of very slight bridges between them.

Plate 4, from the Railroad Gazette, of April 8th, 1881, page 191, is an illustration of a method patented by Mr. Stanhope Perkins, of the Manchester, Sheffield & Lincolnshire Railway, of England.

In this case the manner of securing the stays is sufficiently explained by the drawing, and I will simply say that he adopts this method to overcome the crushing of flue sheets and tubes, which he does in a certain measure, by tightening up the nut at the lower end of the long stays until he strains the crown sheet upward, which undoubtedly aids the ordinary expansion of the fire box.

As you will very readily see, however, this arrangement requires a large amount of labor, and in its complicated construction does not fully secure the desired result of obtaining an open crown sheet. Being much more expensive to construct, it is very questionable whether it could be as substantial as crown bars.

Plate 5 is an illustration from the London Engineer, of March 18th, 1881, page 203, in which the writer and designer claims that the method of Perkins is a colorable imitation of his, he having used this method to prevent the collapsing of tubes some six years ago. As will be seen, he allows for the upward expansion of fire box by slotting the upper ends of the two forward rows of long stays, saying that experience has taught him that this allowance need only be made on these two rows.

On this last system there appears to me to be the following absurdity:

Suppose the fire box should expand and allow the upper end of the long stay to move away from the supporting pin by means of the

slot, what would support that part of the crown sheet? and if it should occur, why the necessity of stays at all? as it is only when there is fire in the fire box and steam pressure in the boiler that the necessity for supporting the crown exists.

If there is any thing in this collapsing of flue sheet due to expansion, I must have overcome it by using half-inch steel in flue sheets, and by allowing three-fourth inch bridges between flue openings, as I have experienced no difficulty from this source whatever.

From these illustrations I think you must admit that the staying as used in Plate 2 is very much the simplest, and, consequently, the the most economical in construction; and as to stability, it has been demonstrated by actual practice that the engines possessing these boilers, and engaged in hauling fast and heavy passenger trains, have made a mileage of over 80,000 miles without having exhibited any signs of leakage or other disturbance, and that the crown sheets are in good and clean condition at the present day.

JACOB JOHANN, M. M.,
Illinois and Chicago Divisions, W., St. L. & P. R. R.

On motion of Mr. Wilder, the paper was received.

THE PRESIDENT—This is a continuation really of the report made one year ago at Cleveland on this same subject; a very interesting one, and something, I think, that every member of the Association is immediately interested in. I certainly am. If there is any way in which we can get rid of the cumbersome crown sheet of the fire box I think we ought to do it. This system seems to me to be a very good one so far as we have light on the subject, and I hope some other member has, during the past year, made some experiments in this line. If any have, I trust they will give us the benefit of their observations. I would say, however, that by a resolution passed two years ago, and which has never been rescinded, one hour, between twelve and one o'clock, is reserved for the discussion of special subjects that may be brought up. It is now about a quarter of twelve, and it is questionable whether we better enter upon the discussion of this question at this time. I will await the action of the Convention.

On motion of Mr. Boon, it was voted that the discussion of the paper just read be postponed, and made the special order for one o'clock, and that Mr. Wilder be requested to read his paper on Experiments with the Dynamometer.

Mr. WILDER, New York, Lake Erie & Western—Mr. Chairman and gentlemen, I had not expected the matter would be brought up in such a formal way as this. I had been requested by some members of this Association, who knew that for some years past I have been allowed by our company to make certain experiments with the dynamometer, to give some of

the results; and on my way here, upon the train the other day, I wrote out a few ideas on the subject which I will be happy to submit to you this way.

Train Resistances and the Dynamometer.

To the American Railway Master Mechanics' Association:

GENTLEMEN—At the request of several members of the Association I would offer a few remarks upon the subject of Train Resistances, the Dynamometer and its Uses. The subject is one on which very little reliable data has been given, and the factors (to represent the different elements) which are now employed are generally believed to be altogether wrong. Believing this to be the case, I commenced during the fall of 1877 to make some experiments and to try to solve these questions. We were at that time about to introduce the consolidation type of locomotive into our service, and we wished to know, if possible, its ultimate capacity in some other way than guess work. Our general superintendent, Mr. E. S. Bowen, and assistant-general superintendent Mr. O. Chanute, at that time in charge of our motive power department, gave me every encouragement, and also allowed the expenditure of some money in the direction of obtaining some positive information of what elements train resistance is composed and of what proportion each element is to the whole.

Starting with a hydraulic weighing machine similar to the one which belongs to this Society, I found that we could not get anything reliable, as it was impossible to get correct readings from which could be detected the traction, the increase or decrease of speed, also to note the exact spot on the road where changes in the reading occurred. So I, after many changes, finally designed a dynamometer which we have found to very accurately record automatically, first the inaction, second the speed, third the angle or direction of the atmospheric resistance in reference to the direction in which the train is moving, and fourth, the force of the atmospheric resistance in pounds per square foot upon a plane set at right angles to the line of the atmospheric resistance.

Besides this there was an arrangement by which the operator could record the mile posts, the length and position of the curves, stations and other such information as might be required. The scale on which this was recorded was of 100 and 400 feet per inch, as it was required.

A brief description of the machine may be interesting. It consists of two rollers, which are moved by gearing which is connected to an axle of the car. Over the roller is drawn a band of paper. As the car moves along the paper is drawn along to the scale before mentioned.

Pencils regulated by springs are made to move over this band of paper by the action of the different forces to be recorded, and the speed was recorded by the aid of a clock arranged to open and close a circuit regularly every ten seconds. The distance between the dots (made by a pencil attached to an armature) marked by this circuit, showed exactly the speed at all times. The force and direction of the atmospheric resistance were recorded by pencils moved by a vane, which held a flat disk up at right angles to the line of atmospheric resistance.

Most of the experiments were made upon the Buffalo division, but many others have been made. Each experiment was made with some specific object in view, as to ascertain the full power of engines of different classes upon different divisions, or to ascertain the amount of power exerted to draw a train over a given piece of road, and then be able to establish a unit by which to gauge the consumption of fuel. While these experiments were being made a a careful record was kept of the amount of coal consumed and water evaporated between the different stops, length of stops, condition of the weather, etc.

The card showed all of the other data, such as speed at all times, traction force used, direction and force of the wind or air resistance. These data have to some extent been tabulated, but a change of duties has prevented my giving the matter any personal attention for some time, and we have not for a year or two done much but to collect more data.

I will try briefly to give you some of the information so obtained. We have found that a Consolidation engine having 20 by 24 cylinders could exert a continuous pull upon the draw bar, exclusive of the power taken to move herself, of from 18,000 to 20,000 pounds, at a speed of 12 miles per hour. That for a speed of 15 miles an hour we could only rely upon from 16,000 to 17,000 pounds; this reduced to horse power gives about 796. We also found that without the use of sand upon an even dry rail, with 11,000 pounds upon each driving wheel, the engine was capa-

ble of exerting 21,000 pounds of traction force for use upon the train, and with sand we have attained as high as 25,000 pounds. We found also that we were able to get as high as 335,278 foot pounds of energy expended in traction per pound of coal consumed. This is an exceptionally good showing; but when it is considered that the value of this same coal for work is about 9,000,000 foot pounds, and we are only getting about 3.5 per cent. in effectual work and the remaining 96.5 per cent. is lost in converting into steam and then into applied power, and the loss from the movement of the engine itself (which would be only about 3 per cent.) we are still advised that there is a large field yet to be explored in the way of economy in the use of fuel. We also found that in the most of our freight trains the total resistance less that due to grade was about 3.25 pounds per ton, and that in no case did it exceed 4.5 pounds per ton for the whole length of the road.

I have brought with me diagrams showing graphically the results of one of our experiments, which consisted in drawing a train of 45 cars, weighing 1,100 tons, from Buffalo to Jersey City. This train was drawn on the Buffalo division as far as Castile (57 miles) with two engines, a Consolidation and an American. From Castile to Hornellsville (34 miles) it was drawn by a Consolidation; from Hornellsville to Susquehanna (142 miles) by an American engine; from Susquehanna to Summit (8 miles) by three engines—two Moguls and an American; and from Summit to Port Jervis (96 miles) by one American engine; and from Port Jervis to Jersey City (86 miles) with a Consolidation with the help of an American engine in a few places.

We found that it required an average of 7,959 pounds for traction for the Buffalo division, 4,198 pounds for the Susquehanna division, 5,143 pounds for the Delaware division, 5,824 pounds for the Eastern division. Thus showing that on east-bound trains the value of a pound of coal for drawing freight was inversely as these figures show, and that an engine should draw as much load the same distance on the Susquehanna division with a little over 4 pounds of coal as the same engine could on the Buffalo division for 8 pounds, thus giving us a unit for comparison of the different divisions for the same kind of service.

The diagrams are on a longitudinal scale of 4 miles per inch; the grade line is shown on a scale of 400 feet per inch. The traction

e scaled to 20,000 pounds per inch, and the speed by a line
iles per inch. I had hoped before this time to be able to
formulæ for computing the resistance due to the friction,
e to curve, and that due to the air at the different rates of
out I have not been able to do so as yet. I am perfectly sat-
at we have always considered those resistances due to friction
this I would include that of the bearing and of rolling of
el upon the track) and that due to curves at too high a factor
present practice, and that we can safely say that it will not
more than $3\frac{1}{4}$ pounds per ton for friction and $\frac{4}{10}$ pounds per
curves.

Respectfully, F. M. WILDER, *N. Y., L. E. & W. R. R.*

ILDER, New York, Lake Erie & Western Railroad—If there are any
s gentlemen would like to ask upon the diagrams I shall be glad to
hem.

PRESIDENT—Gentlemen, this is something that I think is very im-
and that to many of us is somewhat obscure, and I would
that we take a recess of five minutes to examine these diagrams,
der will undoubtedly be ready and willing to explain them, and it
hing I think that will interest every member. If there is no objec-
will have an intermission of five or ten minutes for this purpose.
ess was accordingly taken.]

the recess Mr. W. WOODCOCK, Central Railroad of New Jersey,
at the paper presented by Mr. Wilder be received and incorporated
inutes of the Association.

otion was carried.

PRESIDENT—The business now in order is to discuss any subject
d to us by members of the Association—subjects that are not the
reports of committees. I should, perhaps, have called attention
special hour sooner, so that members could have prepared papers
sted topics which they would like to present for discussion, but
d my mind, and I now have to say that if any one has a ques-
would like to have discussed between now and 1 o'clock we will

. H. BRIGGS, Mobile & Ohio Railroad—I have had occasion lately
wire gauge considerably in weighing material, and I find that great
exists between the Birmingham and American gauge. It has
to me that, perhaps, it would be a good idea to make a sugges-
he Convention that a standard gauge be adopted, either English
ican, so that there will be no confusion; for instance, in filling
r iron. I would suggest that subject to the Convention.

PRESIDENT—Gentlemen, you have heard the remarks of Mr. Briggs;

it is a subject that possesses some importance. In ordering our material it is usual to give it a certain number of wire gauge, and we can readily see that if there are two wire gauges in use, and they are not uniform, it might give rise to a great deal of confusion. This matter is before the Convention; if any one has any remarks to make there is now an opportunity for him to do so.

Mr. BRIGGS, Mobile & Ohio Railroad—I had occasion once to order about a thousand flues for locomotive boilers, and I told the gentleman of whom I ordered them I wanted No. 8 American standard, but by some means they came No. 8 English standard, and the cost to our company was fifteen or twenty cents more a foot. I consider it of vast importance that we have an American standard gauge.

Mr. WILDER, New York, Lake Erie & Western Railroad—For the purpose of having that matter thoroughly understood, I would move that a committee of three be appointed to take this subject into consideration during the ensuing year, and report to this Convention a proper standard wire gague at the next Annual Meeting.

The motion was seconded and adopted.

Mr. SETCHEL, Little Miami Railroad—There is a question that seems to me to possess considerable importance, and that is, Is the Present System of Running Locomotives the most Economical? In introducing this question I have reference to the system of paying engineers either by the day or by the mileage system. I believe there are a few roads in the country that are paying by the mile. I think it is the experience of most Master Mechanics that by adopting a system of work that brings all the energies of the men into play, that with the same facilities, they are almost able to double their capacity. Take a blacksmith shop, for instance, where the men are being paid by the day. If you adopt the process of paying them by the piece you will get two or three times as much work out of the shop as you would to pay the men by the day, and so all through the several shops, and I believe the same principle extends through all the departments of railroading. Now, it seems to me, if we could adopt a contract system of running locomotives that shall enable the engineer to realize some gain for his care in the use of oil, for his care in burning coal, and, as a consequence, doing away with the smoke, that we will accomplish something that will startle us all; and that it is possible to adopt such a system I fully believe. In a conversation, coming over the Erie road, a few days ago with one of our members, I spoke to him on the subject, and he acquiesced immediately that that was the system by which to run locomotives; and said he, "I had some papers that I drew up at the request of Mr. Fiske, when he was running the Erie road, covering this whole matter from beginning to end, and the result, when figured up, would have been to save the road millions of dollars, and at the same time would put a handsome profit in the hands of the men." These papers he presented to Mr. Fiske, who looked them over, and said he believed the plan proposed was the right way, but it was too big a thing for him to com-

prehend, and laid it aside, saying that some time he would take the matter up again. Circumstances over which he had no control prevented the matter from being reconsidered, and I believe that it should now be taken up by the Master Mechanics' Association, and that a committee should be appointed to originate a contract system of running locomotives that shall enable the engineer to realize something from his care in using oil, in burning coal, and in taking care of his engine, and at the same time make a handsome profit for the company. "A stitch in time saves nine," is an old maxim, and when an engineer sees a nut working loose, instead of allowing it to work off and having it put on at a cost of fifteen or twenty-five cents at the end of the trip, he saves this amount, and indirectly benefits himself as well as the employers whom he serves. I would like to hear the opinion of members on this subject, and if it is thought worth while to have a committee appointed to report on it.

Mr. S. J. HAYES, Illinois Central Railroad — Mr. President, I agree with the remarks just made by our worthy Secretary. I remember a good many years ago Mr. Thomas Wynans took the contract of the railroad in Russia, from St. Petersburg to Moscow, and adopted that very same system. He told me the result was that he made just double the amount of money that he would have made if he had run the road under the old system of paying the men by the day. The final result was that he came away from there with about four millions of dollars in his pockets, where perhaps he would not have had more than one million under the old system. I think, as Mr. Setchel says, it would be an excellent plan for us to appoint a committee to look into that matter and make a recommendation at the next meeting of this Association, and I would move that a committee be appointed for that purpose.

The motion was seconded and carried.

Mr. J. H. FLYNN, Western & Atlantic Railroad — I would merely remark that about thirty years ago (Mr. Hayes may remember the fact) the Philadelphia & Baltimore Railroad was run by some parties that leased it, agreeing to pay a certain percentage to the stockholders for three years. They were three practical railroad men. Some months previous to making that offer they were engaged in different departments of the road. One took the machinery department, another took the transportation department, and the other took the running of the road. At the expiration of several months they made a proposition, which was considered at the yearly meeting of the stockholders and accepted. These men run the road for three years. They adopted a policy of this kind, they allowed so much work for a trip a certain number of miles. They said to the engineer, who was using wood worth five dollars a cord, we will say for the sake of the argument, "Every cord of wood you save in a month we will allow you two dollars and a half for." They said similarly in regard to oil and all the supplies. They had a system by which they charged the engineer with his supplies, recording the facts in a journal, which would prevent the engineers from running with too little oil. The result

was that each one of those three men, at the expiration of three years, left that road with what was then considered an independent fortune, something over $100,000. They proposed to again lease the road and increase the per cent. that they paid the stockholders. The stockholders said to themselves, "If this can be done by three individuals, why can we not do it?" They began to talk the thing up, but the matter fell through, and the system was not continued; but the fact was very thoroughly demonstrated that a system of that kind was a very important one both for the road and for the individual men employed by the road. These three men carried the system into every department. It had entirely slipped my memory until Mr. Setchel made his remarks. I think this occurred in 1850. The road previously had made no money. I think it was three per cent. they agreed to pay the stockholders, and pay the interest on the bonded debt of the road, and so successful were they that they were all very anxious to renew the lease for a series of years; but, as stated before, the stockholders began to look into the matter, and thought that they could do the same thing. This is a subject that will require a great deal of consideration. It may vary in different sections, and it is one where, if ever adopted, those controlling the different departments of the road must be prepared to say what they will allow an engineer, in coal for instance, to make his trip. If it requires now three tons or four tons to make the trip, we may say to him, "Now, we will allow you four tons to make a trip. For every ton you save (the coal costing two dollars and a half a ton) we will allow you a dollar and a quarter," and the engineer will become interested, and both the owners of the road and the employees will make more money.

Mr. WILDER, New York, Lake Erie & Western Railroad—Fully agreeing with Mr. Setchel in the main idea he has expressed, I think calling the system "a contract system" is a little unfortunate, as being apt to create a wrong impression as to what is wanted. Many railroads have, I understand, at the present time a plan by which they pay their firemen and engineers for all savings they make in running the engines. They have a system by which, after a careful examination of different methods for ascertaining how many pounds of coal would be equal to a car mile over a given section of road, after a time they will allow so much coal, getting the amount down to a certain percentage, telling the men if they go below that certain figure they shall be allowed a certain premium for the saving during the month. I think to call such a system as that a "premium system," instead of a "contract system," would probably convey more exactly the idea which Mr. Setchel wishes to express.

Mr. SETCHEL, Little Miam Railroad—Mr. President, in reply to Mr. Wilder I would say that I can not agree with him. This premium system brings to the surface a few good men, and those that can not get the premium are discouraged; but under the system which I propose, calling it a contract system, if the men can not get a premium of ten dollars a month they may get one dollar a month. Perhaps that premium would be fully

equal to the man's effort, and if he should increase his effort he would increase what Mr. Wilder calls his premium. If he does not get the premium he does get something, and probably all he deserves. That is why I would call it a contract system. It works itself out in various directions. Take, for instance, the coal consumed. Those of you who have read *The Railroad Gazette* may have noticed that in a recent number Mr. Forney has spoken of this matter, especially in regard to fuel. Now, if an engineer wishes to save a certain per cent. of fuel, he will very soon determine the quality of the fuel. You would not have to rely on Mr. A, B, and C to get at that fact, and tell you to get your coal from this or that mine; but you could call on each engineer who could tell you whether a certain kind of coal is as good or better than some other kind that had been used. They could demonstrate it to an exact nicety. They would say, " We can run over the road with four tons of coal of this kind, and have half a ton left to ourselves; but with that coal we can not do it." This would be the best possible test which would show and bring into market the best coal on the line. The same would be true with grate bars. We know there are various opinions in regard to the necessary amount of air required to consume coal, and here is a means of determining the fact in relation to this. Here is a form of grate bar, the value of which an engineer would at once demonstrate, whether with a certain kind of coal, certain size of opening or grate bar, would be practicable or not. Perhaps it would turn out in some cases that the difficulty was in the firing. This system would demonstrate and locate the cause; for if one man could save a ton of coal, and another man on another train drawing the same number of tons could not save any coal, the difference would be seen to be in the men and not in the engine. Thus we would get the best possible men and device for burning coal, and the best possible coal to burn, and the whole question would be determined without any expense to the railroad, because it would work itself out to a definite conclusion, and the railroad companies could not but be greatly benefited.

Mr. Wilder, New York, Lake Erie & Western Railroad—I wholly agree with Mr. Setchel in all the latter part of what he has said. I think there is no difficulty whatever as to the premium system being practical. Every man who makes a saving will receive a premium. For instance, in drawing a train upon a certain division, say of our Erie road, the average for a series of years we will say is three pounds of coal for every loaded car mile which we have drawn; now, supposing we say to the engineers on that division, " If you make a showing for the next two months, or three, or four, as the case may be, of two pounds and three-quarters of coal for a car mile drawn, we will give you one-half of the saving;" that would be a premium system instead of a contract system. That is the point I was trying to make in criticising the term " contract system," because when we talk about making contracts with the men it seems to convey an idea different from what is intended. A contract implies an obligation on our part to continue to do certain things for a given length of time; whereas it is a very differ-

ent thing to say to the men, "We offer you a premium for everything you save in making your mileage." We will find that every one will make a saving, and ultimately we will get the amount worked down to a fair premium for the work done over and above what we pay them now.

Mr. SETCHEL, Little Miami Railroad—I think Mr. Wilder and I agree in the main points. The only difference between us is in the term. I think, however, it is a contract. What has been known as the "premium system" I think has not been extended quite as far as Mr. Wilder states; that is as a rule. For instance, there has been a premium given on oil, a premium on freight runs, a premium on through passengers, a premium on local passengers, and the ones that make a saving to a certain extent get the premium, while others who try and come nearly up to that point get nothing at all for their efforts; and after a while the result would be a sort of a settled conviction that the whole thing (as I have heard them say sometimes) is a swindle. "I know that man can't run with that amount of oil;" or, "I know that man can't run with that amount of coal. His coal is stolen;" or this or that is done; but if a man is stimulated to get as near the highest premium man as possible, he has something to look for as well as the man who gets the full premium. If it is desired to call it a "premium system," if it it extended in that way, why I have no objection; but I think virtually we should enter into a contract that the man who runs an engine shall run it under certain conditions, and we agree that he shall have a certain amount of that which he saves.

Mr. WIGGINS, Houston, East & West Texas Railroad—This same system of which the gentleman has been speaking, or one nearly the same thing, was considered about twenty-five years ago on the New Jersey Central Railroad. At that time there were only two coal burning engines on the road; the rest were all wood burners. The experiment was tried by Mr. Stearns the superintendent, and succeeded very well indeed. I am not able to state the exact difference it made in the expenses, but there was a great difference in favor of the premium system. This system applied to fuel, oil, repairs, and everything connected with the expenses of running a locomotive, and the engineers were paid according to the cords of wood they saved, and the saving of expense in other directions which they made, and the plan succeeded remarkably well. In a short time the company turned their engines into hard coal burners, and they continued the system until the death of Mr. Stearns. I think there is something of that kind now under Mr. Woodcock.

Mr. W. WOODCOCK, Central Railroad of New Jersey—No, sir, not carried out. We had the premium system some time ago; but, unfortunately, our road got into such a shape that it was discontinued.

Mr. WIGGINS, Houston, East & West Texas Railroad—I remember that some of the men got as high as thirty or forty dollars a month under this system. Some of them did not get but a dollar, but it had a tendency to increase the men's pay and to bring a revenue to the company.

Mr. McCRUM, Missouri River, Fort Scott & Gulf Railroad—It seems to

me that this is one of the most important subjects that ever came before the Convention and it ought to be thoroughly canvassed. I would like to hear something from Mr. Boon in reference to the premium system; I think he can give us some information on that subject which might be of benefit to us all. I believe the system is practiced on his road.

Mr. J. M. BOON, Pittsburgh, Fort Wayne & Chicago Railroad—We have been paying the engineers and firemen for the last five years upon some such a plan as has been mentioned, and we find a decided advance in the saving of expense; indeed since the system was established the saving has been very noticeable. I do not think, however, that the system is perfect. I think the contract system suggested by Mr. Setchel is very much better; that is allowing so much for pulling a car one mile, and at the end of the month the man who pulls the car for the least money is entitled to the premium. We find the system is not working altogether satisfactory on our road, from the classification of the engineers. We have four classes of engineers, and it works dissatisfaction among the men who are not receiving the highest pay. The premium is a monthly one, and amounts to twenty dollars a month to engineers and ten dollars to firemen, and then there is a yearly premium. The men are all working for it. I believe the contract system will be the best and most practical. Estimates should be made on the basis of the cost of the engine for doing a certain amount of work, including fuel, oil, etc., and then the man that does the work for a given period for a less amount than the estimate, should be entitled to the difference between the estimated cost and the amount which the work *actually* cost. I believe a premium system on such a basis would result in a very great saving in operating railroads, and would work satisfactorily.

Mr. WILDER, New York, Lake Erie & Western Railroad — The principal thing to do is to get the best system, whether it is called a "premium system" or a "contract system." A system as perfect as can be had is what is desired.

Mr. BRIGGS, Mobile & Ohio Railroad — The matter could be provided for by appointing a committee, leaving the subject with them. They could correspond with different members, and report a plan at the next Convention, thus giving more time at present for discussing other matters.

Mr. SCHAEFFER, Louisville, Cincinnati & Lexington Railroad — The committee to be appointed on this subject will have quite a problem to solve. I consider it of the greatest importance that correct statements be made of the facts involved. The following points must certainly be considered: First, each engine should be run as near as possible by one man; second, an equal quality of coal and oil should be used; third, the condition of the engine, and especially that of the boiler of each engine, should receive special attention; fourth, there should be a correct statement from the transportation department of the train weight; fifth, an allowance for weather; sixth, a correct statement of switching done, and of delays on the road, which require fuel. My opinion is that nothing remains for us to do except to be careful in making engineers and firemen, and to impart useful information to them

whenever possible. I am in favor of having a committee appointed on this subject.

Mr. WILDER, New York, Lake Erie & Western Railroad — As I understand it, the committee should, first, obtain all the information possible to be found upon this premium system, or upon any other proposed system; second, report to this Convention whether, in their opinion, it is desirable to adopt a premium system; third, recommend the best that can be devised if they report in favor of such a system.

The President then stated the question before the Convention, and on motion a committe was appointed to consider the premium system, so-called, and recommend such action as they may deem suitable.

THE PRESIDENT — It is now one o'clock, and the special business assigned for this hour is the discussion of the last Report on Boiler Construction, by Mr Johann. This matter, as I before remarked of crown-sheet setting and other things mentioned in his report, is something that is very important, and I hope it will be thoroughly discussed by the members.

Mr. SETCHEL, Little Miami Railroad — Mr. President, rather than see this matter drag, I will say what I have to say on this subject first. I would rather give my opinion when Mr. Johann is present; but for one, so far as the crown-bar system which he adopts is concerned (and it is of that I wish to speak), I certainly do not approve of that method of putting on the crown bar with a crown bolt simply screwed through the sheet and slightly riveted over. I think it a very dangerous method of securing the crown sheet. The hold in the sheet is very slight, and if the crown ever gets burned, I think there is no doubt of its going down. I do not think that this bolt, depending simply on the thread and a very slight rivet, is near as strong as the bolt, or as it would be if the bolt was turned the other way and screwed into the crown sheet, or if there was a nut on the bolt. It seems to me this method described in the report is a very dangerous one, and I would like to hear an expression from the members as to their practice in regard to that matter. I would dislike to have these papers presented and nothing said against them if members disagree with them. Then again, so far as the setting or form of the boiler is concerned, I notice that Mr. Johann claims for the sloping crown sheet an absence of scale. It seems to me that the theory that there is any prevention of accumulation of scale on the crown sheet by the sloping process is a fallacy. A stay bolt, perpendicular, will accumulate as much real scale as one horizontal; I can not, therefore, see the advantage of trying to keep a boiler free from incrustation by sloping the crown sheet. It certainly is not as strong a method of setting the sheet; for instance, taking an extreme view of the case (referring to the diagram) the bolt does not go through the sheet at right angles, has not as much thread, and consequently, is not as strong as it would be if it did, and this plan of fastening crown bars, where crown bars are used, it seems to me is radically wrong.

Mr. WIGGINS, Houston, East & West Texas Railroad—On the road where I am engaged we have several of those sloping crown sheets, and I have recently

examined them. I find that they hold the scale just as much as the flat ones. Furthermore, in relation to tapping into the crown sheet, our water is of such a nature that it eats right into the thread, and the stay bolts in a short time let go their hold; so that I agree with our friend Setchel in saying it is a very dangerous way for setting the crown sheet. Those two things have come practically under my notice within a very short time.

Mr. Hayes, Illinois Central Railroad — Mr. President, our Secretary has called my attention to the tapping-in of the crown-bar bolts in this system as represented on the diagram. That system is not new by any means. It has been used in England to my knowledge some twenty-five or thirty years, and was also used by Ross Wynan, of Baltimore, when I was acquainted with him. When he was about to build some engines for the Ohio Railroad he proposed to put in stay bolts in that way. It was not objected to except the liability there was for the crown sheet to blow down. I spoke to him about it. He said that the better plan was, if you were going to get your water low in the boiler, to let the crown sheet go. I told him there were no objections to it, provided the engine did not turn a somersault, which they usually do if the crown sheet goes down. I have had instances of this in my experience where the sheet has blown down; and in one case, on the Michigan Southern, the engine turned two somersaults. I objected to the system on that ground; but we put a nut on the bolt and that made it strong and firm. So far as the sloping crown sheet is concerned, Mr. Wynan had that on every engine he built while I was with him, and for a long time afterward. So I see nothing new in the system of Mr. Johann; but I do see something bad in that system out West where the water is not good. On our road, in some sections of it, scale accumulates rapidly in our boilers, sometimes over an eighth of an inch in thickness. The only advantage I see in the sloping crown sheet is that while the scale is in a semi-liquid state you may wash it off much easier than you could if it was flat, but otherwise it will collect just as much. We also find that where the plates are in a vertical form they will collect a sediment almost as much as any other form. I like to see these things brought forward, and have every man advance his ideas, because it is only by bringing all these ideas together that we obtain our knowledge; but I see nothing particularly new in Mr. Johann's exhibition of his boilers. I would have been pleased if he could have been present to hear what I have said about it.

The President—I would like to ask Mr. Hayes if this accumulation of scale he speaks of on the crown is, strictly speaking, an accumulation of scale. Scale, properly speaking, is lime precipitated by the heat from the water—carbonate of lime, that forms a hard scale. That scale will form on the crown sheet of a furnace no matter what position it is placed in. Where the water is muddy there is a liability that there will be an accumulation of sediment. We should draw a distinction between an accumulation of scale on the plate and an accumulation of sediment on top of a fire door, on the crown sheet, or any place where sediment may lodge.

Mr. HAYES, Illinois Central Railroad—In answer to our worthy President I would state that this scale that I allude to is composed of carbonate of lime and sulphate of lime together with clay. Now we all know that the common mortar used in buildings has but very little solidity without the lime. It is the lime that forms the hard scale, which incorporates into the clay the sulphate of lime, carbonate of lime, and sulphate of magnesia and several other chemical ingredients that make the scale; but the clay of itself can be washed out very readily, while the lime will adhere and become hard. By using the ordinary force of water we can wash out the clay almost entirely, while the carbonate of lime and sulphate of lime become hard like the mortar in a building.

THE PRESIDENT—It seems to me, gentlemen, that that crown being circular, and also sloping backward, would have some features that are valuable in connection with this deposit of foreign matter. I do not think it will prevent the formation of scale proper—lime scale; but there will be less liability of a collection of sediment coming from muddy water, for instance, which a great many roads, in the West especially, have to use at certain times of the year. That furnace [referring to diagrams] might prevent such an accumulation of sediment of mud that would finally become burnt on there very hard. It seems to me that there Mr. Johann has accomplished something that perhaps has some value. The slight slope given to the crown I think can possess no advantage except, perhaps, by getting a little more water over it and to decrease the heating of the surface a very little; it is very hot over the furnace door, and you get more water over that point. That feature may have some value; but I do not think making the top of that crown sheet circular would make the liability less of accumulating an earthy deposit than it would if it was flat and covered with crown bars.

Mr. McCRUM, Missouri River, Fort Scott & Gulf Railroad—In reference to the form of the boiler I agree with the gentleman who has preceded me as to the manner of putting on crown bars. I think that a crown bolt passed through the other way, with a nut on top, makes rather a better and more superior fastening than that [referring to diagram]. In reference to the sloping crown sheet and flat crown sheet I do not think there is any material difference in the amount of accumulation of scale. I think there is some objection in the slope; and if no other, there is an objection to the method of attaching it to the crown for support. I believe, however, there is some advantage in arching the crown sheet the other way. In the West, where we have bad water, of course we suffer a great deal from incrustation. I raise my bars up as high in the boiler as I can raise them, and have room to go into the boiler. We are enabled to get the bars about two and a quarter inches off the sheet; and in new engines we have built, where we have a larger wagon top, we get the bars about three and one-fourth inches above the sheet, using a thimble made of heavy pipe. I have found no trouble where we have got bars up that height, no accumulation of scale on the bars or on the sheet to do any harm, at least not so much; but when we have the

flues removed from the boilers, about once in a year or two, the scale is easily removed and the bars not seriouslly impaired; whereas, when the sheet was down there [indicating on diagram], it would not run more than a year when the crown bars would have to come off. Where I have raised up the bars from two to three inches I have avoided any difficulty of that kind. I put my crown-bar bolts through the other way, making the hole in them a taper with the same tool that the hole is reamed in the sheet, with a flat head or round head bolt, as the case may be, with a nut on top. We have never found any trouble with that coming out. It seems to me that with the bolts riveted on the bottom in that way would be insecure and does not amount to a great deal.

Mr. PHILBRICK, Maine Central Railroad—Mr. President, I know that there is a great difference between the water used for steam purposes in New England and that of the Western States, and that the sediment deposited in boilers by the latter causes much inconvenience that we in New England do not have to contend with. In Maine we have excellent water. We have also a "Maine Law," which works well with us. Perhaps our Western brethren will charge the want of its better success with them to the quality of their water; but that was not what I designed to talk about. It is the practice of some boiler makers, in staying up their crown sheets, to put the stay bolt down through or between the stay bars and washers, and screw them through the crown sheet and put on a nut below the sheet; and sometimes, to make the thing more objectionable, by putting a washer and grommet above the nut. I have had some experience with these and with their results. In a short time the nuts burn off and the bolt is liable to leak. The thread on the bolt having burned off with the nut we can not put on a new nut, nor can we rivet the bolt tight, for the want of a bearing against which to drive up the lower end. To get at the inside and put in a new bolt is inconvenient and expensive. I prefer to screw the bolt down through the sheet, as before mentioned, and to rivet the end well and thoroughly when the boiler is put together, just as the stay bolts are put into the sides of the fire box, and I would like to ask Mr. Hayes if the nuts do not burn off?

Mr. HAYES, Illinois Central Railroad—Mr. President, in answer to Mr. Philbrick I would say that the nuts certainly do not burn off. I have crown sheets now that have been running for eight years, the same crown sheets, the same bolts and the same nuts, and they are in a good state of preservation to day. We do not have the nut very thick, only about half an inch. Our crown sheet is five-sixteenths of an inch thick, while the stay bolt is seven-eighths. Now a nut usually should be the thickness of the diameter of your bolt. We have them five-sixteenths less. [By a reference to the diagrams Mr. Hayes further explained the relative size of the bolts and nuts.] In my report on boilers, some eight years ago, I mentioned the fact that we made a great many experiments with tapping the bolts into the sheets and then pulling them apart, and we found that in no case was the strength of the rivet more than

equivalent to one-third of the strength of the bolt. In such a case you might use a small bolt.

Mr. PHILBRICK, Maine Central Railroad—It appears very strange to me that nuts will burn off as they do with us and not do so in boilers where so much sediment is said to be deposited on the crown sheet, which, it appears to me, would increase the liability to burn, as the water is kept further from the nut and the end of the bolt, and thus there is a less ready conveyance of the heat from the nut and bolt to the water above. In our experience nuts are burned off; and I think that way of fastening the crown sheet very objectionable. As to the fact that a seven-eighths inch bolt is screwed to a three-eighths inch sheet—this does not strike me as objectionable, so far as the thickness of the sheet is concerned, so long as this is sufficient to hold all the strain ever coming at that point. If Mr. Hayes would use a smaller bolt I would not object; but I contend that the crown sheet can be held up as well by bolts screwed through and riveted as the side sheets can be held in place by the same method. I never heard of nuts being used on the side stays.

Mr. BRIGGS, Mobile & Ohio Railroad—I would respectfully say that any members who want to see the truth of this matter demonstrated to perfection, can find the facts stated in the Report of Chief Engineer Sharpe to the Secretary of the Navy. He has a system of diagrams in that work that illustrates the strength of stay bolts put in in every conceivable way; and if that report was closely studied I think we could all derive great benefit from it. I agree with my friend, Mr. Setchel, in regard to crown bars; but there is one important item I would like to call the attention of the members to, which I have never heard discussed much, and that is the absolute necessity of hollow stay bolts. I have been troubled a great deal with stay bolts on our road breaking. I have instituted a system of monthly inspection. There is a hammer held on the inside of the stay bolts, and it is struck on the outside. Of course you know the effect. If it is broken on the inside the hammer will not rebound, if it is not broken it will rebound. I think we ought to call the attention of manufacturers to the subject of stay bolts, so that they may be induced to make a homogeneous bolt with a hole through the center of it, and if we do that we shall then have something that will benefit us as much as anything we have discussed. We have hollow stay bolts which seem to be made of a series of pipes, one side to be welded on to the other; but the weld is not perfect. After getting a weld on several I found it would strip off, and I was unfortunate enough to build two boilers before I discovered that defect, and lately I had every stay bolt taken out and a solid one put in.

Mr. HAYES, Illinois Central Railroad—In speaking of the breaking of the stay bolts we must remember that the stay bolt is subject to two strains, one tensile and the other transverse; and if you will examine stay bolts as they break on the side you will find that they always break near the edge of the outer sheet, not near the edge of the furnace sheet, there being a space of three and a half inches of water there. Now the pressure down on the

crown sheet has a leverage of about four inches on that stay bolt, and it breaks in that way, and hence the strength of the stay bolt is needed sideways as well as tensile; and it will pull the thread off if you bring it within one-third of the strength of the bolt in the crown sheet if you do not have a nut on. We find that those nuts as a general thing become coated over with lime and clay, which forms a kind of covering over them, like the barnacles on the bottom of a ship. We find they will run for eight or ten years without burning off.

Mr. SCHAEFFER, Louisville, Cincinnati & Lexington Railroad—In regard to hollow stay bolts that Mr. Briggs speaks of, I would say that a hole can be drilled from the outside through the thickness of the shell of the boiler that would indicate the defect as well as if the stay bolt was hollow all the way through. We have engines run in that way very satisfactorily. A hollow stay bolt is very expensive, and I think another method can be adopted which would answer the same purpose.

Mr. SETCHEL, Little Miami Railroad—I gather from what Mr. Philbrick has said that he has never tried the principle spoken of by Mr. McCrum, which is identical with that used on our road; that is we cut a thread next the head of the bolt made accurate by a gauge, and screw the bolt in from the bottom and the nut on the top of the crown bar. Mr. Philbrick complains that the difficulty is that the nut burns off. There you have got no nut to burn off. When the head of your bolt is wasted away you have then got as much strength as you had when you riveted the bolt there first. Now I would like to hear what objections there are, if any, to a plan of that kind. It seems to me that the head of the bolt is very much stronger than a nut can be, and there is no water to destroy the thread. You have the full strength of your bolt all the time, and it seems to me to be far better than to screw the bolt in from the crown sheet above. It was intended that a member of the Boiler Committee, Mr. Peddle, would make a Report on the Strength of Stay Bolts and the Manner of Securing the Crown-bar Bolts, but he was unable to do so; but if the members will refer to that report spoken of by Mr. Briggs, they will find the strength of the bolt is just about what Mr. Hayes states it, one-third; and if that is the case I see no reason why we may not use a lighter bolt; but it is better to use the full head below and put the nut on top.

Mr. A. G. EASTMAN, South-Eastern Railroad—I would like to ask Mr. Setchel if it is necessary to tap through the sheet at all. I have been accustomed to putting a countersunk head, and either riveting the top or putting a nut on the crown bar, and have never seen any injurious effect.

Mr. SETCHEL, Little Miami Railroad—In answer to Mr. Eastman I would only say the chances of its being tight are a great deal better when tapped in than when it is only driven in; although I know very many builders practice driving them in through a reamed hole and make a good job; but I think the work endures longer to tap it and screw the head closely to the crown sheet.

Mr. WOODCOCK, Central Railroad of New Jersey—In regard to the crown bar and bolt, I would say that we have recently had some locomotives constructed and adopted that plan of screwing the crown bolt from the bottom. We have used several locomotives with crown bars fastened with bolts, as has been remarked by Mr. Eastman; but while that makes a very strong job, I have no question that when the crown sheet becomes buckled and warped, especially if you get a little low with your water, you will find there will be some difficulty—the bolts will leak. That has been our experience. Otherwise they make a very strong fastening for the bolt and a very simple one. When the water has become low and the bolts have leaked, we have had to take them out and put in new bolts, and recently we have had to adopt this plan of tapping on the bottom and bolting on top. This is more expensive; but I do not think a crown bar can be too well secured, especially with a flat crown sheet.

Mr. WIGGINS, Houston, East & West Texas Railroad—We have a series of plugs that we wash out through, so that it gives us a chance to see the arched top of the sheet. We find that the arched top corrodes and fills up with mud just as much as the flat one. We have three plugs on a side, and we take them out once in two weeks so we can learn the exact condition of the boiler. So far as the benefit of the arch is concerned, in regard to mud and sediment, we think we do not find any benefit from it whatever. We find those plugs are a great benefit in the top of the crown-sheet plate.

Mr. HAYES, Illinois Central Railroad—I would like to say a few words more in regard to hollow stay bolts We have been using them for a good many years. There is a party now making hollow stay bolts for us; they are not made of pipes, as Mr. Briggs spoke of; but the iron is made in the form of a half moon, and then set together in that way [illustrating], and put in the furnace with a spindle on the inside, about four feet in length, and they are worth from ten to fourteen cents a pound. We are in the habit of using them around the front part here [referring to diagram] and certain places right around there. We put in hollow stay bolts at any point where the stay bolts are liable to break—we have been using them for quite a number of years In other parts we use the solid stay bolts because they are much cheaper. It is simply round in those places where they are liable to break that we use them; and we are putting in a larger stay bolt than formerly, making them an inch where the others were seven-eighths, and we think we have accomplished a very excellent thing.

At this point a motion was made and carried that the discussion of this subject be closed.

The Secretary then read the Report of the Finance Committee as follows:

Report of Finance Committee.

To the American Railway Master Mechanics' Association:

GENTLEMEN—Your Committee have examined the accounts of the Secretary and Treasurer and find them correct, and would recom-

mend the assessment of $5.00 upon each member to defray the expenses of the coming year.

Respectfully,

GEO. RICHARDS,
W. WOODCOCK, } *Committee.*

It was voted that the report be received.

The President stated that an invitation had been received from the Rhode Island Locomotive Works for the Association to visit their establishment, and also a similar invitation had been received from the Nicholson File Company, and as these two establishments are near together the visit to both could be made at the same time. Action on these invitations was postponed until to-morrow.

The President also announced that a committee representing several business interests of the city of Providence had invited the Association to partake of a clam bake at Silver Spring to-morrow, and that a steamer would be in readiness to carry the members at 2 o'clock. The invitation was accepted.

THE PRESIDENT—Our Constitution provides for a certain number of Associate Members, and it also provides the way in which persons desiring membership can join. [Section 2 of Article IV read.] I think our Associate Membership is not full. We have an application indorsed by three of our Active Members, and it of course becomes necessary, in order to dispose of this business, to appoint a committee. I will appoint George A. Coolidge, of the Fitchburg Railroad; James Eckford, of the Cincinnati, Hamilton & Dayton Railroad, and George E. Boyden, of the New York & New England Railroad. This communication can be referred to them and their report can be made to-morrow.

It was voted that the communication be received and placed on file.

The Secretary read a letter from William A. Harris, of the Harris-Corliss Engine works, inviting the members of the Association to visit their establishment as often as their engagements and duties would permit. This invitation was also accepted and ordered to be placed on file.

The meeting then adjourned until 9 o'clock A. M. Wednesday, June 15th.

SECOND DAY'S PROCEEDINGS.

The Convention was called to order at 9 o'clock by President Lauder.

The Committee appointed yesterday to consider the candidacy for new Associate Members reported favorably upon the name of Lewis F. Lyne. The report was received, and the Convention proceeded to ballot on his election. The President appointed Mr. Philbrick, of the Maine Central Railroad, and Mr. Griggs, of the Providence & Worcester Railroad, to act as tellers. The vote was declared as follows by the President:

Whole number of votes cast 23; Mr. Lewis F. Lyne has received 23 votes, and is unanimously elected an Associate Member of this Association.

THE PRESIDENT—The next business in order will be the reading of the Report of the Committee On the Best Means of Producing Better Combustion in the Use of Bituminous Coal as a Fuel for Locomotives. The report is submitted by James Boon, Chairman of Committee.

The Secretary read the report as follows:

Report of Committee on the Best Means of Producing Better Combustion in the Use of Bituminous Coal as Fuel for Locomotives.

To the American Railway Master Mechanics' Association:

GENTLEMEN—It is best not to further complicate this problem by including the load hauled, grades, curves, speed, etc., in measuring the efficiency obtained, as each of these or all of them together produce the total resistance which is overcome by the combustion of coal in evaporating water. Any additional resistance from whatever cause requires a proportional larger amount of steam to be used and of coal burned.

If a locomotive uses a large quantity of steam for the amount of work done, it will also use a large amount of coal for the production of that steam. The usual method of measuring locomotive performance by the number of tons hauled per mile per ton coal, has naturally resulted in charging any want of economy to the fire box and boiler and to bad combustion.

While this may be right in many cases, it might as frequently more properly be charged to bad economy in the use of the steam in the engine.

The efficiency of a good steam boiler is about seventy-five per cent., while the best marine engines utilize only ten per cent. of the heat equivalent of the coal, and the efficiency of American locomotive exclusive of fire box is only about five per cent.

The loss of heat in a locomotive is then largely due to the use of the steam in the *engine* rather than to its production in the boiler; but the opportunity for reclaiming some of this loss is more favorable in the boiler than in the cylinder; and it would seem that the best way to investigate and improve them would be to consider each subject separately.

Boiler performance— including fire box, ash pan, stack, and exhaust nozzle.

Engine performance—including cylinders, valves, and machinery.

The subject of "The Combustion of Coal" then has only to deal with *boiler performance.* The measure of boiler performance is *the number of pounds of water evaporated from* 212° *F. per pound fuel*, and as a high rate of evaporation requires a high economy in the combustion of coal, *this rate* may also be taken as a measure of the completeness of the combustion when boilers of the same class are compared.

The rate of evaporation per pound fuel is materially influenced by the extent of heating surface and by the rate of the combustion of coal. The greater the heating surface and the less the amount coal consumed per hour, the greater, within certain limits, is the rate of evaporation.

By the English method of measuring boiler efficiency the weight of the water fed to the boiler is taken as representing the total evaporation; but it is well known that the steam as used in a locomotive is not dry, and the quality of the steam as to its degree of saturation is another element affecting the actual rate of evaporation.

The heating power of a coal depends upon the available combustible matter in it, and this is shown by a chemical analysis.

The amount of water evaporated per pound coal can, by the aid of a chemical analysis, be converted into the equivalent amount water evaporated per pound pure carbon, and the figure thus made comparative for different coals.

A report on boiler performance, to be useful for comparing the

coal combustion and water evaporation in different boilers, should give the following data:

1. Grate surface.
2. Total heating surface.
3. Pounds water evaporated from 212° F. per pound coal.
4. The amount of water in the steam.
5. Pounds coal burned per square foot grate per hour.
6. Chemical analysis of the coal.
7. A complete drawing of the boiler, showing fire box, grate, ash pan, stack, and exhaust nozzle.

We think it is possible from such information to determine the degree of perfection reached by any locomotive, in the combustion of coal.

The equivalent evaporation from 212° F. is obtained from the formula,

$$W^1 = W \times \frac{H + 32 - t}{966},$$

in which W is the weight of water evaporated per pound coal, from water supplied at a temperature t, into steam of the total heat H, measured from 32° F., and W^1 the equivalent weight of water as evaporated from and at 212° F. (See Clark's Manual, page 768.)

This requires any experiments on boiler performance to note the temperature of the water in the tank, and the average pressure of steam.

The data for estimating the degree of saturation of the steam can be obtained by a calorimeter arranged as a small surface condenser. The temperature of injection, overflow, and of condensation from the steam, should each be noted, and the weight of condensing water and condensed steam obtained. The rapidity of combustion is shown by the pounds coal burned per square foot of grate per hour. The time should be actual running time, exclusive of stops. By combining the *rate* of combustion with the rate of evaporation, we get the rapidity of *evaporation.*

The chemical analysis of the coal should show per cents. of

Moisture, Total Carbon, Hydrogen, Ash, Sulphur, and Coke.	The coke less the ash gives per cent. fixed carbon, which, substracted from total carbon gives the volatile carbon.

From such an analysis it is possible to calculate the heating power of the coal as well as the amount of air required for the complete combustion of the fixed carbon and of the gas.

In the foregoing we have attempted to show that coal combustion in locomotives has only to deal with boiler performance; that the measure of boiler performance is pounds water evaporated per pound coal; that this rule of evaporation is influenced by surface ratios, rate of combustion, quality of steam, and quality of coal.

It is desired thus to place locomotive performance, so far as it relates to coal combustion, on a more definite basis, so that any future reports on the subject may contain such data as will enable one to judge intelligently of the degree of perfection reached in the economical combustion of coal on American locomotives.

We will notice next the methods in general use for economical coal burning, the amount of air required for the combustion of the gas in different coals, and the manner in which it is supplied.

THE BEST MEANS OF BURNING BITUMINOUS COAL IN LOCOMOTIVES.

The scientific principles involved in the combustion of coal were well understood twenty-five years ago, and it is a remarkable fact that the best means for their practical application in a locomotive *now known* were *then used.*

Thomas Yarrow, on the Aberdeen Railroad, in 1857, used the first brick arch and air tubes in the fire box substantially as now applied, and the hood or baffle plate inside the fire-door was used in England at the same time.

By a process of the survival of the fittest, these three arrangements, the brick arch, air tubes, and baffle plate, are the only ones of the many devices which have been used for economical coal burning in general use on locomotives at the present day. In England the arch and the baffle plate are used almost universally.

The brick arch is gradually growing in favor in this country, and its merits deserve a more general recognition than it has heretofore received.

The baffle plate has been frequently tried in America, but it is usually abandoned on account of its rapid destruction by the intense heat of the fire. This method of introducing air over the fire seems to be preferred to Clark's air tubes in England, where both

plans originated and where both have been the subject of extensive experiments.

It would seem that further experiments in this country were desirable in order to devise a baffle plate of such shape and composition that it will resist the action of the fire long enough to make it pay to use them.

Hollow stay bolts and Clark's air tubes have been applied without any definite idea of the amount of air they would supply, or of the amount required above the fire for the combustion of the gases.

One report gives the total area of openings in hollow stay bolts as giving the best results at 3 square inches, while another gives as an average of experiments with Western coals $\frac{1}{50}$ of the grate surface, or from 40 to 50 square inches. The quantity of air required above the fire varies with different coals and with different modes of firing. With a light fire and a large grate the air drawn through the fire with a strong blast may be nearly sufficient for the complete combustion of the gas, and the benefit derived from the air tubes very slight. With a deep fire more air is required above the fire, and the improvement in economy from the use of the air tubes is greater.

The carbureted hydrogen gas should not be allowed to escape at a temperature less than 800° F., or it will not be consumed. It is important, therefore, that the quantity of air admitted be subject to regulation, and a greater quantity supplied when the coal is first applied and most gas distilled, and less air as the gases are consumed. The amount of air required varies also as the engine is worked lightly or heavily. If too great an excess of air is supplied, when little gas is produced, the gas will have its temperature reduced below the point of ignition and a volume of smoke produced.

The chemical combinations necessary to produce perfect combustion of different kinds of coal are well understood; but the difficulty, which is *not* fully understood by those who are criticising railroad managers for not obtaining better results with coal, is that there are few, if any, roads which obtain their supply of coal from one mine. The consumption is so great that the supply must come from several mines, and in the case of one railroad the coal is supplied from *nine* different mines. Each of these coals will give a different analysis, and each requires different conditions to produce perfect combustion.

Locomotives have to be arranged to give the best average results with all coals supplied, and not to suit that from any one mine.

The air required for the combustion of the gas in any coal increases with the percentage of volatile carbon and hydrogen in it. To illustrate the difference in coals, in this respect, we give analyses of three samples of coal from different mines, the amount of air necessary for the perfect combustion of each, and the area of opening above the fire to supply that quantity, supposing it to be at constant pressure. Two coals used by Mr. N. E. Chapman on the Cleveland & Pittsburgh Railroad ("A"), from Steubenville, and "B") from Salineville, and one used on Pittsburgh, Fort Wayne & Chicago Railroad ("C"), from Mansfield mines.

For the combustion of one pound of carbon we require 152 cubic feet of air, and for one pound of hydrogen 457 cubic feet.

Coal A.

Fixed Carbon	50.18 per cent.	$\times$ 152 =	7,627	cubic feet air.
Volatile Carbon	21.69 "	$\times$ 152 =	3,296.8	
Hydrogen	6.79 "	$\times$ 457 =	3,103.2	
				6,400 cubic feet air.

These figures are for 100 pounds coal, and for 2,000 pounds we have $7,627 \times 20 = 152,540$ cubic feet air for the fixed carbon, and $6,400 \times 20 = 128,000$ cubic feet air for the gas.

If the engine burns 1 ton coal per hour, and we admit all the air for the gas above the fire, then 128,000 cubic feet air per hour will have to pass through the air tubes if the fire door is kept closed.

The pressure of blast required to burn this amount of coal per hour on a grate surface of 18 square feet, is about 3 ounces, and the velocity of air at this pressure is 9,000 feet per minute, or 3,752 cubic feet through an opening one inch square in one hour.

Then $128,000 \div 3,752 = 34$ square inches, the area of the opening above the fire, for the combustion of the gas in coal A under the conditions given.

Coal B.

Fixed Carbon	$48.36 \times 152 \times 20 =$	147,014	cubic feet air.
Volatile Carbon	$21.48 \times 152 \times 20 =$	65,300	
Hydrogen	$5.74 \times 457 \times 20 =$	52 460	
			117,660 cubic feet air for the

gas. $117,660 \div 3,752 = 31.4$ square inches, the area of air tubes required for this coal.

Coal C.

Fixed Carbon	63.95 per cent.	$\times 152 \times 20 =$	194,408 cubic feet air.
Volatile Carbon	10.92 "	$\times 152 \times 20 =$	33,200
Hydrogen	4.85 "	$\times 457 \times 20 =$	44,320
			77,520 cubic feet air.

$77{,}520 \div 3{,}752 = 20.7$ square inches opening of air to gas in coal C.

We have now the theoretical areas of openings for air above fire for the combustion of gas in one ton per hour of

Coal A	34.	square inches for	128,000 cubic feet air.
" B	31.4	" "	117,660 " "
" C	20.7	" "	77.520 " "

The relation of these figures to each other is,

C = 100
B = 150
A = 164
Coal B requiring 50 per cent. more air than C.
" A " 64 " " " C.

These differences show the importance of each road experimenting with its own coal to obtain the best results, instead of accepting and following the proportions, shapes, and methods of other roads using different coals under different conditions.

Accompanying this report are drawings of the Standard Fire Grates, as used on Wabash Railroad, Cleveland & Pittsburgh Railroad, Missouri, Kansas & Texas Railroad, Lake Shore & Michigan Southern Railroad, and Pittsburgh, Fort Wayne & Chicago Railroad; drawing of smoke-stack on Lake Shore & Michigan Southern Railroad, and smoke-stack and exhaust nozzle on Pittsburgh, Fort Wayne & Chicago Railroad.

The Chairman of your Committee had thought for a long time that the short exhaust nozzle in general use could be improved.

The interesting experiments by Mr. John E. Martin, as described in his paper read at the Cincinnati meeting in 1879, confirms this opinion.

A series of experiments with the high compound nozzle, on the passenger engines of the Pittsburgh, Fort Wayne & Chicago Railroad, has produced similar results, and lead to a general use of them on that class of engines, with an important improvement in the combustion as well as in the area of flues, cylinders, and valves.

A condensed report of experiments with high and low nozzles is given below.

The trial was made on Class A, Engine No. 158, first with the low double nozzle as regularly used, then with the high compound nozzle. The fire box was cleaned from mud and scale, the tubes had been in service three months since last cleaned, the holes in fire box for Clark's air jets were closed.

The coal on tender was carefully weighed and not used until the start from the station, that used in starting the fire being taken from another supply.

The engine was taken into terminal station with fire and water in the same condition as at the start, the coal and water as given represents that consumed while the train was under way.

The water was measured with a float, and graduated rod having a guide on the manhole of tank. Each inch in depth of water, on the surface of the water space, was taken as weighing 475 pounds. The readings of the float were noted before and after filling the tank and at termini.

The temperature of the water in tank, and of the atmosphere, was measured with a Fahrenheit thermometer.

A record of the arrival and departure at each station was kept in order to get the actual running time exclusive of stops.

Indicator diagrams were taken with each nozzle at speeds varying from 20 to 50 miles per hour, and with Allen valve. The first four trips between Fort Wayne and Chicago were made with the low nozzle. Trips one and two, nozzle 3 inches diameter; trips three and four, nozzle $3\frac{1}{8}$ inches diameter. The high nozzle was compound, with $3\frac{1}{4}$ inches double, and 4 inches single nozzle, as shown by accompanying blue print.

The coal was from Mansfield Coal Company, Pittsburgh. Analysis by George Goetz, Otis Steel Company:

Moisture	1.85
Carbon	74.87
Hydrogen	4.85
Ash	4.87
Sulphur	152
Coke	68.82

Coke	68.82
Ash	4.87
Fixed carbon	63.95
Volatile matter	29.33
Moisture	1.85
Ash	4.87
	100.00

The indicator diagrams show very little difference in the back pressure with the two nozzles, and no perceptible difference in the steam and compression lines. It may be safely said that the high nozzle has no bad effect upon the action of the steam in the cylinder. The evaporation tests are favorable to the high nozzle, and, as a result of the trial, we feel justified in extending the use of it.

The conclusion your Committee have arrived at after investigating this subject is, that no general rule can be given for producing better results in the combustion of bituminous coal, but that each coal must be treated separately for its special chemical composition.

This also applies to the size of the coal, some of which will give good results with large pieces, and others with small pieces.

The size reported to answer best for most coals is that which will pass through a ring 3½ inches diameter.

The mechanical appliances for producing combustion will necessarily be varied for the different qualities of coal, and it will be seen that five different styles of grates (as shown by the blue prints) are in use on as many roads, each, no doubt, giving good results in its own locality

Where it is possible to bank fires, and avoid cleaning the furnace at the end of each trip, a very great economy of fuel is obtained.

For economical coal burning two things of vital importance are necessary: 1st, A large fire box and plenty of heating surface; and, 2d, care and intelligence on the part of the fireman.

The Committee is under obligation to the following gentlemen for assistance in making this report: Messrs. George Cushing, James Sedgley, N. E. Chapman, Jacob Johann, and John Ortton; also to Wm. Forsyth, of my own office, who conducted all the experiments.

Respectfully submitted,

JAMES BOON, *Chairman of Committee.*

[A large number of engravings of smoke stacks and grates, accompanying this report, the most of which have appeared in the Railroad Gazette, your Committee deem it unnecessary to insert them here. SECRETARY.]

On motion of Mr. Woodcock it was voted that the paper be received.

THE PRESIDENT—This subject is now open for discussion. It is a very important one, and I hope the members will see fit to express their views fully.

Mr. HENRY ELLIOTT, St. Louis, Mo.—On hearing the reading of this

report, I did not understand that any thing as to the heat of the smoke arch had been taken into consideration in making these experiments. Now, it occurs to me as the result of my own experience on combustion, that it is a very important matter to know the temperature of the smoke arch as to whether we are producing perfect combustion, which can only be decided, in my opinion, by considering the temperature of the smoke arch in connection with the amount of water vaporized by a certain amount of fuel; and, in all these experiments, I did not notice that any thing of that kind has been taken into consideration at all. Now, in regard to the matter of high nozzles, as recommended by the Committee, in preference to the low nozzles, that is a question that depends on some thing else. A certain arrangement in the fire box will work better with a high nozzle than with any other arrangement, and that is where, perhaps, Mr. Boon got better results with the higher nozzle than he would if there had been different arrangements in the fire box, with an opening in the grate or above the furnace. The object accomplished by the height of the nozzle is to produce an equal use of the whole of the flues. When you produce that you produce all that can be produced by the height of the nozzle. It is to utilize the whole flue surface. If you get your nozzles too low, the flues get stopped up, and, in my judgment, there should be something to measure the heat of the smoke arch to determine what we are carrying off. If we carry the heat through the flues, it is gone, and, I believe, there is some loss in that way. One member says he uses the brick arch, and gets the best results; but another man will put in a brick arch, and it is no better for him than the ordinary fire box. The idea of coming right down to producing so much steam from a pound of coal is a fine point of figuring; but we do not know half as much about the results as we would if we knew the actual condition of the air opening through the grate or the opening above. If we were to take two engines, one having one arrangement and the other another combination, we would get at the result more surely.

Mr. Setchel, Little Miami Railroad—There is one point in Mr. Boon's report about which I would like to ask him a question ,or two, and that is, In the use of the high nozzles whether he succeeded in clearing the smoke arch and the bottom rows of flues equally well as in the use of the low nozzle? I have always found that as soon as you commence raising your nozzles you commence filling up the bottom of your smoke arch, and, consequently, the bottom rows of flues. How it is done I am not able to tell; but I understand that in England they succeed in running their nozzles nearly to the top of the smoke arch and get rid of their sparks in some way; I do not know how. I think we have never been able to do it in this country. As soon as we raise the nozzles we fill up the smoke arch, and a low nozzle seems to be a necessity. That is my experience.

Mr. Boon, Pittsburgh, Fort Wayne & Chicago Railroad—As to the high nozzle filling up the smoke arch with cinders, that in no way interferes with the engine making steam. The only danger is from the cinders catching fire.

That is entirely overcome, however, by taking the petticoat pipe and arranging it as shown in the diagram. [By reference to the diagram Mr. Boon explained the arrangement referred to.] The cinders are no detriment to the working of the engine, but we find the advantage to be that the engine steams very regular, and we find also that the engine throws less sparks. With a low nozzle the sparks are thrown into much greater activity, and it will be found that engines with low nozzles give out in the lower flues first invariably; and by looking the matter up you will find that it is because the greatest amount of the gases pass through the lower flues and a greater amount of heat. The fire is but eighteen inches from the lower flues, so the fire really comes around the crown sheet and passes through there. [Indicating on diagram.] We can not run one of those locomotives with low nozzles over eight months without taking out the flues; we have now run these engines a year and the flues are perfectly tight, something we could never accomplish before. There is another advantage in the use of the high nozzle. The engines will not use so much water. Engines doing the same work, day after day, must necessarily evaporate the same amount of water. The matter was brought to my attention, and I found with the low nozzle the engine would get very hot, make steam very quick, and blow off; and it is necessary to open the fire door to cool them down, that thing occurring every fifteen or twenty miles, and, of course, all the steam blown off is a waste of water.

Mr. PHILBRICK, Maine Central Railroad—I would like to ask Mr. Boon a question. I understand Mr. Boon that he uses the tall pipe in a certain arrangement of stack [referring to diagram] peculiar somewhat to his own road. I suspect, also, that he has a boiler of modern make, of large size. That may be the case. What I want to get at is, would the tall blast pipe in our smaller engines, where we are a little troubled to get steam, give as good results as the lower blast pipe, providing we use the diamond stack? Mr. Boon says that with the tall pipe his engines use less water, and do not get hot, do not steam so quick. Now, then, if it does not steam so quick, does not his success depend upon the large fire box giving a uniform heat with a low blast, and under those circumstances would he succeed with a smaller fire box, such as we sometimes find in our old engines, with that kind of blast? I only inquire for information, because it is a practical matter with me; and I had an idea that Mr. Boon's favorable results depended upon his large fire box rather than upon his tall pipe. Would the tall blast pipe answer the purpose in our small engines as well as the lower?

Mr. JOHN BLACK, Dayton & Michigan Railroad — This experiment was conducted with the same smoke stack you see there [referring to diagram]. The boiler was 52¾ inches in diameter, and the fire box about 6 feet long.

THE PRESIDENT — I think Mr. Philbrick has raised a very important question in regard to the use of the high blast pipe. With the ordinary diamond stack the straight portion of the stack, which is effective for producing a vacuum, is comparatively short; whereas, the so-called straight

stack has a long straight top, and is very much more effective, it seems to me, than the ordinary diamond stack. I suppose the reason for using the diamond stack is to provide an efficient spark arrester, as well as a pipe to carry off the products of combustion, but with the tall straight pipe or stack, high exhaust nozzles could probably be used with greater success than they could in any other form of stack. I think it would be very difficult to use high nozzle pipes and keep the smoke arch free from sparks with the diamond stack.

Mr. Boon, Pittsburgh, Fort Wayne & Chicago Railroad — As I understand it, Mr. Philbrick wishes to know if I have tried the high nozzle in the diamond stack as well as with the straight, or what is known as the Smith or standard stack. That [referring to diagram] is the Smith stack, and high nozzles work equally well on the diamond stack.

Mr. Setchel, Little Miami Railroad — Do you put in the nozzles in the diamond stack in the same manner you do in the straight stack?

Mr. Boon — It is the same construction but a little different size.

Mr. Setchel — And without a cone?

Mr. Boon — Without a cone.

Mr. Setchel — And a netting?

Mr. Boon — And a netting. The only question is whether the netting, being worn out so readily, it would not be cheaper to put in a cone. But an engine has been running on our road, with this arrangement I have described, since last March without a cone, and last week we examined the stack and found it to be in perfect order.

Mr. Setchel — Now, one thing more I would like to ask Mr. Boon. As a rule I think there is an impression that a high exhaust nozzle like that [referring to diagram], with a very slight taper, would produce back pressure in the cylinder. I would like to know about that.

Mr. Boon — We thought that would be the result, and put an indicator on one of our engines with a high nozzle. We found that up to 45 miles an hour there was no difference, but after we got above that there was less back pressure. Here is a low nozzle diagram and here is a high nozzle diagram, and the gentlemen can all see and determine the cause of this result for themselves.

Mr. Setchel — Mr. President, I have no desire to prolong this discussion any longer than is beneficial, but I have a desire to learn all I can while here, and one matter I would like to have explained by Mr. Boon, or by any member of the Convention, is this, why there should be less back pressure running at a high speed with the high nozzle, and less at a slower speed with a low nozzle? That is something which seems to me to be unaccountable. Mr. Boon states that with a very high speed, over 45 miles an hour, there was less back pressure with the high nozzle than there was with the low nozzle, and the diagrams show it.

Mr. Boon — The exact reason why there was a difference in the back pressure I am not prepared to say, but there is the indicator diagram that shows

the result. We were very much surprised, and made another trial, but the results were the same.

Mr. PHILBRICK, Maine Central Railroad — If the gentlemen will give us a little of their experience I think it will be valuable. My own experience has been that I get more steam with a low nozzle. I know the disadvantage of having a low nozzle by the sparks getting into the cylinder. I know it is very desirable to have a high nozzle in this respect, but I have resorted to putting in low nozzles, and get more steam out of a small boiler. I would like the experience of the members as to whether gentlemen have succeeded better with a high or low nozzle?

The PRESIDENT called upon Mr. W. O. Hewitt, Toledo, Peoria & Warsaw Railroad, to give his experience on this subject. Mr. Hewitt said he had paid some attention to the matter, but not sufficiently to enable him to give any result that would be of value to the Association.

Mr. S. J. HAYES, Illinois Central Railroad — In response to the suggestion of Mr. Philbrick, I will give some of my experience in the matter. I have found, as a general rule, that engines would steam as well with the high nozzle pipe as with the low, but the trouble was to get rid of the sparks. We found the cinders would accumulate in the smoke box, and in reversing the engine we would shut in the sparks, and in a number of cases we have had even the cylinder head knocked out by reversing the engine when running at a pretty rapid rate of speed; but where we put the exhaust pipe up near the smoke arch, and provide means of getting rid of those cinders, we found that the engine would steam about as well with the tall exhaust pipes as they did with the lower ones. We usually run our switch engines with the high nozzle pipes, and take out the sparks twice a day, from ten to fifteen bushels, and if we allow no air to get to them, so they can not become ignited, they work very well. In regard to engines not having any more back pressure running at a high speed, I would account for it in this way, that running with the tall nozzles at very high speed you form a vacuum in the exhaust pipes and the speed being so great you do not give time for the air to fill in, hence you do not get the back pressure, but at a slow speed the air fills in every time you create a vacuum before the next exhaust.

Mr. ELLIOTT, St. Louis, Mo.— Mr. President, the subject of high and low nozzles carries me back to my earlier experience, which has been something like Mr. Philbrick's. About three years ago we used a tall pipe, running up almost into the bottom of stack, then we were using small fire boxes, and it was a very difficult matter to make the steam required. About that time we commenced to use low nozzles with the petticoat pipe, and I think our road has engines that do almost as well again as with the high nozzles. We have some large fire boxes that hardly require any exhaust at all to produce combustion, and make steam almost without any artificial draft, and I do not think that is the proper place to try the benefits of the height of the nozzle All of the old Master Mechanics can look back to the time when they commenced to use the petticoat pipe with the low nozzle, and they will remem-

ber the good results they got from them. As to cleaning out the bottom of the smoke arch, some use the petticoat straight pipe running up to the top of the smoke arch, and others use a sectional pipe, but generally you can clean the sparks independent of the height of the nozzle; of course you must have your nozzle high enough, so the sparks will not pile up around it and be drawn in; but when you have it high enough so they will not do that, I do not see that the sparks ought to get into the low nozzle any more than with a high one, because the sparks are not going to fly up unless there is something to draw them.

Mr. WOODCOCK, Central Railroad of New Jersey — In my experience I think the high exhaust pipe has some advantages over the low; but I am not in favor of the extreme high exhaust pipe in burning anthracite coal. I do not believe it is possible to get as much steam with the high exhaust pipe as with the low. We have demonstrated that on some of our small engines, by working them to the full extent of their capacity, and we find we get better results with the low exhaust and petticoat pipe. We are now using quite a number of exhaust pipes about 16 inches high, and they seem to work very satisfactorily.

Mr. SCHAEFFER, Louisville, Cincinnati & Lexington Railroad — As far as my experience goes in the use of nozzles and petticoat pipes, I think a good deal depends on the engineer and fireman. I think we have done all that can be done so far as the construction of the nozzle and petticoat pipe is concerned. The operation of the nozzle and its results depend also a good deal on the season. One season we have snow and rain. We have hot weather at present, and I think we need a different nozzle from what we did last new year. We ought to have a small nozzle in cold weather, and a larger one in warm weather, and ought to have different nozzles at the different seasons of the year. An intelligent engineer will always attend to these things.

Mr. A. G. EASTMAN, South-Eastern Railroad — I would like to ask Mr. Woodcock if he ever tried any straight stacks on small engines with his high exhaust pipe. Our neighbors, the Grand Trunk, Quebec, Montreal & Ottawa Railroads, are using a high nozzle and straight pipe, and I have been informed very successfully. Their engines, of course, are all large ones, with large fire boxes and a great number of flues; as has been remarked with a great amount of heating surface, and there is probably no trouble in getting steam. The question is, is the straight stack and high nozzle an advantage over the other?

Mr. WOODCOCK, Central Railroad of New Jersey — I would answer that question by saying that we have been and are using it still. I believe the straight stack is the only one that should be used; I think it is the cheapest and most effective. I certainly would be in favor using the straight stack on all engines if we could provide the necessary appliances to prevent setting fires. That is the only difficulty we have to contend with. In our State the laws are very strict in reference to that matter, and we have to be very careful in regard to it. I believe we are moving in the right direction when we

increase the heating surface and get large boilers and large fire boxes, so we can run with large nozzle, and thus prevent drawing the fire through the flues, and we shall not encumber the smoke box with sparks. We have endeavored recently to secure this large surface in some of our engines, and we expect to get a better result in that respect than heretofore. I think a brick arch is a step in the direction of preventing drawing sparks through the flues; I believe something of that character will prevent it to a great extent.

THE PRESIDENT—I would say for the information of Mr. Eastman that on Mr. Woodcock's road, the Central of New Jersey, anthracite coal is used extensively. I think the Grand Trunk Railroad is burning bituminous coal with the arrangement that he speaks of. Those engines that Mr. Boon has been experimenting with are also using bituminous coal successfully with the straight stack. I speak of this so that there need be no misunderstanding in regard to the use of the straight stack on the Central Railroad of New Jersey. If there is no one who desires to discuss this question further, we will now close the subject and proceed to the next business, which is the Report of the Committee on the Best Form of Construction of Locomotives for Fast Passenger Trains. The report is submitted by Mr. Woodcock, of the Central Railroad of New Jersey. It is in the hands of the Secretary and will now be read.

The Secretary read the report as follows:

Report of the Committee on the Best Form of Construction of Locomotives for Fast Passenger Trains.

To the American Railway Master Mechanics' Association:

GENTLEMEN—Your Committee appointed to investigate the subject: Best Form of Construction of Locomotive for Fast Passenger Service, beg leave to present the following report:

In carrying out the plan adopted by the Association at last Annual Convention no circulars were sent out. The Chairman sent letters of inquiry to a number of Master Mechanics and others asking for information on the above subject. Part of the number have replied to the same.

The question seems to be, to your Committee, is, which of the two classes of locomotives, the American or eight-wheel engine, or the locomotive having one pair of driving wheels and a four-wheel truck, are best adapted for fast passenger service.

What is the limit of high speed, is a question yet to be answered.

Some years ago 30 to 35 miles per hour was considered quite rapid traveling, but in the last few years our business men; and

others, are not satisfied with this rate of speed, but are only suited when they can go at the rate of 50 or 60 miles per hour; or it is even thought the distance between New York and Philadelphia (90 miles) should not exceed 90 minutes in time. Your Committee based their inquiry on 50 miles per hour.

As to the merits of the locomotive with one pair of driving wheels, we have not received much practical information; but we were pleased to hear from a number who have had some experience on American railroads with this style of locomotive.

We refer to Mr. James Sedgley, of the Lake Shore & Michigan Southern Railroad, who says: For hauling passenger train, required to make 50 miles per hour, my preference is for a locomotive with dimensions as follows: Boiler, 48 and 51 inches diameter; grate, 72 inches long; 180 tubes, 2 inches by 11 feet and 4 inches long, giving an area of 18 square feet of grate surface, and 1,200 feet of heating surface in the boilers; cylinders, 17 by 24 inches; one pair of driving wheels six feet in diameter, placed forward of fire box, with one pair of trailing wheels behind, and a four wheel truck forward.

With locomotives of this description, with a train consisting of one baggage, two coaches, and two sleeping or drawing-room cars, I believe they would be fully capable of making easily (without stops) 50 miles per hour.

Mr. Sedgley further says he was connected with a road, in 1846, which had quite a number of locomotives with a single pair of driving wheels, the general plan of which was well adapted for fast running. Comparing with eight-wheel locomotive, he says they have a class, with boiler, of the same dimensions as above, with cylinders 17 by 24 inches; 4 driving wheels, 5 feet 6 inches diameter; center to center of driving wheels, 8 feet 6 inches; weight, 36 tons, which seems to be well adapted for hauling train of 8 and 10 cars at a speed of 40 miles per hour, evaporating about 6 pounds of water with 1 pound of coal. But for 50 miles per hour his preference would be for the locomotive with single pair of driving wheels so arranged to increase the weight on driver in starting the train. This style of engine possesses features recommending them as less complicated and less liable to give out on the road.

Mr. J. N. Lauder, Superintendent Rolling Stock of the Northern Railroad of New Hampshire, says in reference to this subject: That the locomotive, with a single pair of driving wheels placed

forward of the fire box, has undoubtedly some meritorious features, it being plain and simple in construction. The coupling rods, which we considered a source of danger, when high speeds are attempted, are wholly avoided on this class of locomotives. For special service, and when very high rate of speeds are desired and light trains are possible, it also may have advantages over any other known form. But all locomotives of this design have the same disease, viz.: a want of adhesion, and this disease has been fatal in this country by our system of car construction and with heavy trains to be hauled. In regard to the American locomotive we have an engine that has sufficient adhesion to give it great power, and is capable of running at as high speeds as the most sanguine could desire.

The only element of danger in this class of engine is the liability of the coupling rods breaking. This, I believe, to be a mechanical difficulty, owing to the faulty design and construction of the rods. I believe a coupling rod can be designed that will stand the strains of service on fast engines with safety.

Mr. Lauder furnished a drawing of a coupling rod that he believes will overcome the difficulty. This rod is somewhat similar to the rods used on the Grand Trunk Railroad of Canada, and has been in use for a number of years, and, in no instance has one of them broken.

In conclusion he says: He is thoroughly in favor of the American or eight-wheel engine for fast passenger service on American railroads. The engine being properly proportioned to suit the load and service required.

Mr. Jacob Johann, Master Mechanic of the Wabash, St. Louis & Pacific Railroad, would recommend for fast passenger service a locomotive having cylinders 20 inches diameter and 24 inches stroke, with four coupled driving wheels 72 to 84 inches diameter; also to have a boiler of sufficient capacity to furnish steam under all circumstances.

He has no doubt but that a locomotive designed, embracing the above dimensions, and under the care of a competent and intelligent engineer (which he considers an important factor in the matter of fast passenger service), would be able to maintain a uniform speed of from 50 to 60 miles per hour, with a train not exceeding 200 tons in weight. The running time on his road, stops not included, is about 43 miles per hour. Size of engine cylinders 15 by 22 inches; driving wheel, 5 feet 6 inches diameter; weight of train, 70 tons.

With a locomotive having cylinders 17 by 24 inches; driving wheels, 5 feet 6 inches diameter; weight of train, 205 tons, a speed is maintained of 37 miles per hour, stops not included.

Mr. Johann says, in his opinion and from his experience, he does not believe locomotives with single driving wheels can be run successfully on American railroads.

Mr. A. B. Underhill, Superintendent Motive Power of the Boston & Albany Railroad, says the average speed of express trains on their road is 40 miles per hour, each train having from 6 to 8 coaches, about one-third of which are drawing-room cars. Average weight of drawing-room car, 68,000 pounds; weight of coach, 46,000 pounds, carrying 70 passengers each. He has had no experience with single driver locomotives, and judging from what he has learned of the performance of that class of engines, is not very favorably impressed.

Mr. Underhill gives the dimensions of this standard locomotive, as follows:

Diameter of boiler	50 and $52\frac{1}{4}$ inches.
Number of tubes	175.
Diameter of tubes	2″ inches.
Length of tubes	11 feet $2\frac{1}{2}$ inches.
Inside fire box	66×36×64 inches.
Water spaces, fire box, sides, back, and front	3, 3, $3\frac{1}{2}$ "
Total heating surface	1,143 square feet.
Cylinder diameter and stroke	18 ×22 inches.
Steam ports length and width	$14\frac{3}{4}$×$1\frac{1}{8}$ "
Exhaust length and width	$14\frac{3}{4}$×$2\frac{3}{4}$ "
Travel, lap, and lead of valve	$4\frac{3}{4}$ inches travel, $\frac{7}{8}$ inch lap, $\frac{1}{32}$ inch lead.
Diameter driving wheels	5 feet 6 inches.
Diameter truck wheels	30 inches.
Center to center driving wheels	7 feet 9 inches.
Center driving wheel to center cylinder	11 " $\frac{11}{16}$ "
Total wheel base	23 " $1\frac{7}{8}$ "
Journal driving axle	7 ×$7\frac{1}{16}$ "
Journal truck axle	$4\frac{1}{2}$×$8\frac{1}{4}$ "
Journal main crank pins	$3\frac{3}{4}$×$3\frac{3}{4}$ "
Journal back crank pins	3 ×3 "
Weight on driving wheels in working order	44,250 lbs.
Weight on truck wheels in working order	25,150 "
Total weight in working order	69,400 "

Mr. Reuben Wells, Superintendent Machinery of the Louisville & Nashville Railroad, says, in reference to this subject, that they have no fast engines in the sense that term is generally understood. In designing a locomotive for fast running, the first thing to figure on is the boiler. If steam is furnished at the usual pressure as fast as required, any reasonable good working engine will make as fast time with a train as most people wish to travel. Fast trains are good in their way, but are an expensive luxury.

Mr. Wells gives the dimensions of what he considers their best working engines on their fast trains, as follows:

Diameter and stroke of cylinder	18×24 inches.
Length and width of steam ports	17×1¼ "
Travel of valve, Allen's patent	5 inches.
Length of fire box	72 "
Number of tubes	200.
Diameter of tubes	2 inches.
Height of boiler wagon-top	6 "
Diameter of boiler	54 "

One dome over fire box. Brick arch used in fire box.

He says we can not run these engines out of steam; and they have made the run from Nashville to Louisville, 185 miles, in five hours, including stops; an average speed of 37 miles per hour. Train, 5 to 6 cars; grade, 40 to 80 feet per mile. Mr. Wells mentions this to show the result of a good size boiler.

Mr. W. W. Evans, one of our Associate Members, says, in constructing locomotives for fast running, it appears to him that the only great difficulty is in making the reciprocating parts, particularly the connecting rods, sufficiently strong to stand the cross strain on them. To overcome the difficulty of breaking rods, he suggests the following plan of their construction, viz.: By laying up as close together as possible steel wire $\frac{1}{16}$ of an inch square, until the size in length and section is obtained, and then brazing them all in one solid mass in a bath of melted gun metal. Make the rods as light as possible by plaining out the sides, leaving the ends solid. He believes a rod made in this manner would never break at any speed. The amount of gun metal in such a rod would be inappreciable, if the work is skillfully done.

Mr. Evans says this process is the same as by which the "Woodbridge Cannon" are made, and which are said to be the only cannon

which have never burst. He is of the opinion that a bar made up in the above way would be able to stand a tensile strength of 160,000 pounds per square inch.

He is not in favor of locomotives having one pair of driving wheels, the tendency being to put too much weight on that pair, which would be severe on the permanent way, as proved by this class of locomotives in England. Another difficulty to overcome is the journals heating, which he believes can be remedied by having the axles made of homogeneous metal, turned true as possible; brass good and properly fitted; journals never over-loaded, and the lubricator good and continuous; under these conditions they should never heat.

A letter is here appended from F. M. Wilder, Superintendent Motive Power of the New York, Lake Erie & Western Railroad, giving his views on this subject, including dimensions for a passenger locomotive to burn bituminous coal, also some interesting statements on traction derived from dynamometer tests made on the above road. Mr. Wilder gives the average speed on their road at 40 to 45 miles per hour for 428 miles.

Your Committee recommend that the letter be read and printed in the Minutes.

Much has been said and written in reference to the high rate of speed attained in Europe by locomotives with a single pair of driving wheels, and desiring to get some reliable information as to the sizes, rate of speed, etc., of the same in use there, a member of Committee, Mr. John Ortton, Mechanical Engineer of the Canada Southern Railroad (who is familiar with the performances of English locomotives), has prepared a statement of the same, including his own views on this subject. He also furnishes a description of the Fontaine locomotive recently placed on this road for trial.

I have also a letter from Mr. James Boon, Master Mechanic of the Pittsburgh, Fort Wayne & Chicago Railroad (member of Committee), who has had some experience with locomotives running fast passenger trains, and has recently built several new locomotives for this service. A description of the same is included in letter.

Your Committee recommend these letters be included as part of their report.

The only locomotive built with a single pair of driving wheels (for fast passenger service) for quite a number of years in the United

States, was built by the Baldwin Locomotive Works in April, 1880, for the Philadelphia & Reading Railroad Company, to run on the Bound Brook Line, between Philadelphia and New York, and was built to run at a speed of sixty miles per hour, using anthracite coal as fuel.

The dimension of the same was as follows.

Cylinders	18×24 inches.
Diameter of driving wheels	6 feet 6 "
Diameter of trailng wheels	45 "
Diameter of truck wheels	36 "
Total wheel base	21 feet 1 "
Distance from center of driving to center of trailing wheels	8 feet.
Size journals, truck axles	5×8 inches.
Size journals, driving axles	8×9½ "
Size journals, trailing axles	7½×8½ "
Size journals, tender	5×8 "
Diameter tender wheels	36 "
Diameter boiler at smoke box end	52 "
Diameter tubes	2 "
Number of tubes	198.
Length of tubes	12 feet 2¾ "
Length of fire box	96½ "
Width of fire box	84 "
Depth of fire box	44 and 51 "
Total amount heating surface in boiler	1,400 square feet.
Feed water supplied with two injectors, steam ports	1⅝×16 inches.
Exhaust ports	3×16 "
Allen valve	⅞ inch lap.
Capacity of tender	4,000 gallons.
Weight on driving wheels	35,000 to 45,000 lbs.
Weight on trailing wheels	15,000 to 25,000 "
Weight on truck wheels	25,000 lbs.
Weight of engine in working order	85,000 "

By the use of an auxiliary steam cylinder placed under the waist of the boiler, in front of the fire box, the bearings on the equalizing beams, between trailing and driving wheels, could be changed to a point forward of their normal position, so as to increase the weight on the driving wheels when required. The adhesion could thus be varied between the limits of 35,000 to 45,000 pounds on the single pair of driving wheels.

Your Committee had hoped to have been able to furnish some records of the performance of this engine, but on account of its not being in regular service, no records could be obtained except the account of a trial trip made between Philadelphia and Jersey City, a distance of 89.4 miles. The train consisted of 4 passenger cars, and left Philadelphia at 11:16 A. M., arriving at Jersey City at 12:54 P. M.; time, 98 minutes. On return trip, with 5 passenger cars left Jersey City at 2:07 P. M., arrived at Philadelphia at 3:47 P. M.; time, 100 minutes. During the trip a distance of 2.8 miles was run in 2 minutes, on an ascending grade of 16 feet to the mile. It was thought this engine would be capable of running at a speed of 75 miles per hour with a train of ten cars.

The Philadelphia & Reading Railroad Company have built at their own shops two locomotives expressly for fast passenger service, said to be the largest passenger engines ever built in the United States. These engines are in service at the present time on the Bound Brook Line, running between Philadelphia and Bound Brook, a distance of 59.2 miles. These engines are capable of making very fast time, as shown by the reports.

In July, 1880, engine 506 hauled 15 passenger cars, carrying nearly 900 passengers, from Philadelphia to Bound Brook, the ruling gradient being 59 fet rise per mile, at an average speed of 42 miles per hour. The aggregate weight of train and passengers, exclusive of engine and tender, being in excess of 360 tons.

At another time, engine 411 hauled 10 loaded passenger cars from Philadelphia to Bound Brook in 1 hour and 19 minutes, making usual slowing up for two miles of bridging.

Several diagrams have been taken from these engines when running at a speed of 72 miles per hour on a level. Boiler pressure 105 pounds per square inch, cutting off at 8⅝ inches. Train consisted of 4 passenger cars.

The regular schedule time on fast line, between Wayne Junction and Bound Brook (54.9 miles), is 64 minutes, including one stop and slowing down three times. This involves an average speed of 56 miles per hour for nearly 55 miles.

The peculiarity of these engines is the construction of the boiler, which is expressly adapted for burning anthracite coal. The fire box is placed entirely above the driving wheels, its exterior width being

8 feet 8 inches, and its length 10 feet 5 inches. The general dimensions of engine is as follows:

Cylinders	21 in. diam. 22 in. stroke.
Diameter driving wheels	5 feet 8 inches.
Center to center driving wheels	7 feet.
Diameter truck wheels	33 inches.
Diameter boiler	58 inch. to 52 inch.
Number of tubes	184.
Diameter of tubes	2 inches.
Length of tubes	10 feet 2½ "
Length of fire box, inside	9 feet 6 "
Width of fire box, inside	8 feet.
Grate area	76 square feet.
Heating surface of tubes	982 " "
Heating surface of fire box	135 " "
Total heating surface	1,117 " "
Exhaust nozzle, single (variable)	3¾ to 5¾ in. diam.
Wheel base	21 feet 1 inch.
Weight on driving wheels	64,250 lbs.
Total weight of engine	98,200 "

The above engines are said to possess good steaming qualities, which would be expected from the dimensions of heating surface, especially grate area, which is necessary for the successful burning of anthracite coal.

The Chairman of the Committee says their Company (Central Railroad of New Jersey) have recently placed on their road two very large and powerful engines, built for heavy fast passenger service, designed to haul 12 fully loaded passenger cars from New York to Long Branch, a distance of 45 miles, in sixty minutes, including ferry, holding up for drawbridges, crossings, etc. In a trial trip, a few days since, one of these, in running from Elizabeth to Bound Brook, on the Philadelphia line, a distance of 19 miles, made the run in 20 minutes with 4 passenger cars; also, on another trip, the engine developed a speed at the rate of a mile in 48 seconds.

The engines have not yet been assigned to a regular train, but he has no doubt but they will establish a good record. These engines are built to burn anthracite coal, having large fire box and boiler. The fire box being placed directly over the top of frame, thus allowing increased grate area. The boiler being placed in this manner dees not seem to interfere with the steadiness of the engine when

running at a high rate of speed. They ride very well for engines of this size. The general dimensions are as follows:

Cylinders	19×24	inches.
Diameter driving wheels	5 feet 8	"
Diameter truck wheels	32	"
Center to center driving wheels	7 feet 6	"
Diameter boiler at smoke-box end	52	"
Number of tubes	200.	
Diameter of tubes	2	inches.
Length of tubes	11 feet $5\frac{7}{8}$	"
Length of fire box, inside	126	"
Width of fire box, inside	$43\frac{3}{4}$	"
Heating surface, fire box	140	square feet.
Distance from center boiler to rail	$82\frac{1}{2}$	inches.
Steam ports	$1\frac{5}{8} \times 16$.	
Exhaust ports	3×16.	
Travel valve	$5\frac{1}{2}$	inches.
Allen valve	———	
Total wheel base	21 feet 8	inches.
Weight on driving wheels	68,000	lbs.
Total weight	93,200	"

From the information received, and with what experience your Committee have had in reference to this subject, they are of the opinion that for express passenger service, under all circumstances, the American, or eight-wheel engines, is the best adapted to meet the wants required on American railroads. The dimension of the same to be worked out to suit the service, grade, and condition required on the several roads.

It would be difficult for your Committee to specify or furnish plans or dimension of engines for this service. They can only say what should be some of the special features; and, first of all, we would say, furnish ample boiler capacity. We think this is the most essential thing to be considered in designing a locomotive for fast running. This has been referred to in a former part of the report. Another feature would be to reduce the length of coupling rod as short as possible; that, to a great extent, will lessen this danger of breaking rods. For supplying feed water to the boilers use injectors, and avoid the difficulty of keeping pumps in repair, which is no small item. We are of the opinion that with cylinders 18 inches diameter and 24 inches stroke, driving wheels

with 68 or not to exceed 72 inches diameter, and with boiler of sufficient capacity to furnish steam under all conditions, this with a steam pressure of 140 pounds per square inch, there will be no difficulty in maintaining an ample speed of 50 miles per hour with a train of 5 to 6 cars.

While it seems to be a necessity to run passenger trains at high speed, your Committee think it involves increased cost of repairs, and requires careful attention on the part of those under whose care this class of engines come, and makes it, as has been said, an expensive luxury.

Very respectfully submitted,

WM. WOODCOCK, *M. M., C. R. R. of N. J.*,
JAMES M. BOON, *M. M., P., Ft. W. & C. R. R.*, } *Committee.*
JOHN ORTTON, *M. E., Canada, S. R. R.*,

Report of Mr. John Ortton on the Best Form of Construction of Locomotives for Fast Passenger Trains.

To the American Railway Master Mechanics' Association :

GENTLEMEN—In reporting as to the Best Form of Construction of Locomotives for Fast Passenger Trains, your Committee must be guided chiefly in their remarks by what has been and is being done upon those roads which professedly run trains on fast time schedules, preferring that course rather than dealing in theories, which, more or less, would be only of speculative value.

In the United States and Canada the type of engine generally adopted for passenger service is that known as the eight-wheel American pattern, having two pairs of coupled driving wheels, of 5½ feet or 6 feet diameter, and cylinders 16 or 17 inches diameter by 22 or 24 inches of stroke. Engines of these dimensions are seen daily hauling passenger trains of from 5 to 7 cars, weighing from 120 to 150 tons, and running at the rate of 40 to 50 miles per hour where the road is tolerably level and straight; but with the loads and speeds stated the full tractive power of the engines appear to be fairly taxed.

On some of the principal roads in England there are but two types of engines used for passenger service. One is that having single driving wheels of 7 feet or 7½ feet diameter, and the other is that with two pairs coupled, of 6½ feet or 7 feet diameter. The one with single drivers has been for many years the standard adopted on the London and North-Western, and also on the Great Western

Railway, the only difference between them being that of construction necessarily involved by a difference of gauge, the former road being the ordinary 4 feet 8½ inches gauge, and the latter the 7 feet gauge. The engines, with coupled drivers, is in more general use on other roads where trains are heavy and stoppages are frequent; but, as a matter of fact, the single driver engine is considered better adapted for speeds of 50 to 55 miles an hour with light trains and long runs.

One special advantage favoring high speeds on English roads is the fact that, almost invariably, trains of all classes are started and run throughout strictly in accordance with schedule time tables, besides which very complete arrangements are carried out for running both passengers and freight trains, so that there is barely a possibility of rear collisions; and, as a rule, all bridges and viaducts are substantially built of either iron or stone, so that no slackening of speed is necessary when running over them.

The following are the leading particulars of the single driver class, called the "Lady of the Lake," adopted as the London & North-Western Railway standard passenger engine:

Outside cylinders	16×24 inches.
Driving wheels	7 feet 7½ inches diameter.
Leading and trailing wheels	3 " 8 "
Steam pressure in boiler	125 lbs. per square inch.
Blast orifice	4½ inches diameter.
Height of center of boiler above the rails	6 feet 6 inches.
Length of wheel base	15 " 5 "

Weight on wheels in working order:

Leading	21,056 lbs.
Driving	25,760 "
Trailing	13,664 "
Total	60,480 lbs.

Area of fire-box grate	14.9 square feet.
Fire box heating surface	85 "
Number of tubes	192.
Length of tube	10 feet 9 inches.
Outside diameter of tube	1⅞ inches.
Tube heating surface	1,013 square feet.
Total heating surface	1,098 "

The engine has a fire-brick arch, and two small openings in the front sheet of fire box for air passages, closed by regulating doors.

The weight of tender loaded is 39,200 pounds. The tender is fitted with apparatus for picking up water from a trough laid between the rails, which is effectually done while running at any speed over 15 miles per hour. By picking up water at Conway, this engine has run a distance of 130 miles, from Holyhead to Stafford, without stopping.

On the Southern Division of the London & North-Western Railway, a large number of single driver engines, called the "Bloomer" class, were employed for many years in running the fastest trains, and gave most excellent results, rivaling the "Lady of the Lake" class, and in many respects carrying off the honors.

The following are the leading particulars of the "Bloomer" engine:

Inside cylinders	16×22 inches.
Leading wheels	4 feet 6 inches diameter.
Driving wheels	7 feet diameter.
Trailing wheels	4 "
Extreme wheel base	16 feet 10 inches.

Weight of engine in working order:

On leading wheels	22,170 lbs.
On driving wheels	27,664 "
On trailing wheels	15,120 "
Total	64,960 lbs.

Length of fire box inside	5 feet 3 inches.
Width of fire box inside	3 " 7 "
Area of fire grate	18.81 square feet.
Number of tubes	195.
Length of tubes	12 feet ½ inch.
Outside diameter of tubes	2⅛ inches.
Heating surface of fire box	165 square feet.
Heating surface of tubes	1,152 "
Total	1,317 square feet.

This engine has run at the rate of 55 miles an hour, with a train of 18 carriages, weighing 108 tons; the consumption of fuel being 36 pounds of coal per mile, and evaporating 7.34 pounds of water per pound of coal.

Of the four-wheeled coupled passenger engines used in England, one of the best of that class is in general use on the London &

South-Western Railway, and it is well adapted for hauling trains of 150 to 200 tons, at a speed of 45 miles an hour; the consumption of coal being under 30 pounds per mile.

The following are the leading particulars of this engine:

Outside cylinders	17×22 inches.
Driving wheels, 4 coupled	$6\frac{1}{2}$ feet diameter.
Fire box, length inside	5 feet 4 inches.
Fire box, width inside	3 " 4 "
Grate area	$17\frac{3}{4}$ square feet.
Number of tubes	242.
Length of tubes	10 feet $1\frac{5}{8}$ inches.
Outside diameter of tubes	$1\frac{9}{16}$ inches.
Heating surface of fire box	121 square feet.
Heating surface of hollow stays	36 "
Heating surface of tubes	992 "
Total	1,149 square feet.

The weight of this engine in working order is about 36 tons, of which the weight on drivers is 24 tons. The economy in fuel with this engine is due to a feed-water heating apparatus, which was a patented appliance invented by the late Mr. Joseph Beattie, who for many years was the Locomotive and Car Superintendent of the road.

On the Canada Southern Railroad it is an every-day occurrence to run passenger trains of four or five cars, weighing from 125 to 150 tons, at the rate of 45 or 50 miles an hour, and frequently at a much higher speed, with engines having cylinders 16 by 22 inches, and four-coupled driving wheels of only 5 feet 6 inches diameter, the steam pressure in boiler being at 125 pounds per square inch. It is, however, only fair to say that the road is practically both straight and level, and pre-eminently suitable for fast running. The sharpest curves, which are very few in number, being only 3 degrees, or 1,916 feet, radius; while the heaviest grades, also few in number, do not exceed 15 feet to the mile or 1 in 352.

With such advantages in the road bed, and its splendid track, there has been no difficulty experienced in running over it at the very highest speed attainable by the above class of engine, which, not unfrequently, has been at the rate of 60 miles per hour, and over, for long distances, with trains weighing about 75 tons. The travel of the pistons, when the engine is running at 60 miles an hour is 1,121 feet per minute, which shows the necessity of having the

driving wheels properly and correctly balanced, to counteract the effect of the reciprocating and revolving masses as concentrated at the crank pins. Unless these disturbing masses are accurately counterbalanced, it would be absolutely unsafe to run the pistons at such an enormous speed, but all parts being properly conditioned, there does not appear to be any particular limitation to the speed of the piston while under steam pressure.

There is, however, one feature in the construction of engines intended for high speeds which deserve some consideration, and it is this, whether, as a question of safety, the coupling rods should be dispensed with or retained? Long experience with single driver engines has proved them capable of hauling heavy loads at the highest speeds; and that being a fact, is it desirable to continue our practice of building high speed passenger engines with coupled drivers, and especially those intended for moderately light trains? It is, doubtless, well known to the majority of Master Mechanics that the breaking of crank pins and coupling rods is an occasional source of anxiety, and not unfrequently they have proved disastrous both to life and property. With well-balanced wheels, and the coupling rods shaped deep and thin, so as to give them elasticity and freedom when running around curves, the tendency to break may be minimized, so to speak; but, nevertheless, danger lurks within and about them from the very nature of their performances as they are whirled to and fro, and yet, after all, they are not absolutely necessary appendages to be retained at all risks.

In concluding this report it may be proper to mention that there is now in actual service a new type of engine known as the "Fontaine" engine, from the name of its inventor, Mr. Eugene Fontaine. This engine is constructed on an eminently novel principle, and so far as its powers have been developed it appears to possess the remarkable qualification of being capable of acquiring a speed far beyond that of any other type of engine of equal piston power.

An engraving of the Fontaine engine was given in the Railroad Gazette, dated February 25, 1881, from which it will be better understood at a glance than by any description of writing. It will be seen that the driving wheels and connecting machinery are mounted near the top of the boiler; and directly below the driving wheels are another pair of a double construction, forming, as it were, ordinary wheels for running upon the track, with auxiliary wheels of smaller

diameter, projecting outside, but solid with the inner ones. The rims, or tires, of the auxiliary and upper wheels are turned cylindrical, and the distance apart exactly correspond with each other.

The upper, or driving wheels, communicate the motive power to the auxiliary wheels by friction, and as the latter are solid with the track wheels, any movement of the upper wheels causes a corresponding movement of the lower ones in a ratio proportionate to their respective circumferences or diameters.

The diameter of upper wheel is 72 inches;
The diameter of auxiliary wheel is 56 inches;
The diameter of track wheel is 70 inches.

By dividing the number of feet in a mile by the circumference of track wheel, we get the revolutions it will make in one mile, thus:

$$\frac{5{,}280}{18{,}326} = 288 \text{ revolutions.}$$

And multiplying 288 by the diameter of auxiliary wheel (56), and dividing the product by the diameter of the upper wheel (72), we get the number of revolutions the upper wheel will make in a mile, thus:

$$\frac{288 \times 56}{72} = 244 \text{ revolutions of upper wheel.}$$

And as the stroke of piston is 2 feet, multiplying the revolutions of the upper wheel by 4 (the length of double stroke), we find the travel of piston per mile will be $224 \times 4 = 896$ feet per mile; and at the rate of a mile a minute, or sixty miles an hour, the speed of piston with this engine will be only 896 feet per minute, which is about 23 *per cent. less* than the piston of an ordinary engine would travel if the engine was running 60 miles an hour.

The engine has shown some remarkable results in its performances, both for fast speed and hauling heavy loads; but as it has not yet undergone complete tests it may be better to wait the results of investigations now going on before making them public.

Respectfully submitted,

JOHN ORTTON.

Report of James M. Boon on the Best Form of Construction of Locomotives for Fast Passenger Trains.

WM. WOODCOCK, ESQ., *Chairman of Committee on the Best Form of Construction of Locomotives for Fast Passenger Trains:*

DEAR SIR—The above subject is a complicated one, as in constructing a locomotive for fast passenger service a number of conditions have to be considered, such as the weight of trains, grades, curvature of road, distance run without stops, and kind of fuel used.

There are but few roads in this country whose passenger business will justify them in building special engines for fast trains.

The business being very irregular, one day three coaches are sufficient, and on another day six or nine coaches are required, and engines must be provided to make time with any train until the limit of the power of the engine is reached.

The requisites of an engine for this business would be power, adhesion, and boiler capacity; one that would start quickly and attain speed on the shortest possible time, and when running to do the work with an economical consumption of steam and fuel.

This is the problem, and I apprehend it is a more difficult one than most people have any idea of.

I do not think any special form of construction is necessary for high speed locomotives. I believe that the ordinary American locomotive, with two pairs of drivers, when properly designed and constructed, is capable of making any speed required.

Engines, with a single pair of drivers, have been tried and are now used in Europe, and are effective so long as the weight of the train is below the adhesion of the drivers; as soon as it exceeds this the wheels slip.

When the adhesion is made great enough to overcome the resistance of a heavy train, the weight on the single pair of drivers becomes too great for the strength of the rails which are then destroyed.

There is a limit to the strength of rails, though they be made of steel; this limit is reached for 70-pounds rails when the weight on each driver exceeds 15,000 pounds.

Of course the rail could be increased in weight and strength, but it is not likely that railroad companies would be willing to relay their lines with heavier rails to enable them to use a special engine for passenger service.

A locomotive with 17 by 24 inches cylinders, and 4 drivers 5 feet or $5\frac{1}{2}$ feet diameter, makes a very good class of engine for general passenger service for either fast or slow trains.

The enormous evaporative capacity of the boiler of such an engine is shown by the performance of our class "A" engine hauling 9 cars at an average speed of 35 miles per hour. The consumption of water was 14,500 pounds per hour; the consumption of coal was 2,900 pounds per hour, and 160 pounds coal burned per square foot grate per hour.

This intense combustion and rapid evaporation is required for a $52\frac{3}{4}$ inches boiler to supply 17 by 24 inches cylinders when the engine is worked to its fullest capacity.

The theoretical weight for adhesion can be obtained with cylinders of this size, and very satisfactory results obtained.

By increasing the size of the cylinders over 17 inches the difficulty of efficient steam supply and adhesion becomes apparent.

Increasing the diameter and reducing the stroke of the cylinder is now being discussed; but I have not gone into the subject far enough to express an opinion, but it appears to me it would be an advantage.

On roads where stops are frequent a 5 feet driver, with 17 by 24 inches cylinders, will do good work.

I know there are many persons who claim that a speed of 60 miles per hour can not be made with a 5 feet driver and ordinary train. I also know this to be a mistake, as there is no difficulty in doing it. The piston spread is high; but it is claimed that the most effective stationary engines built are those with high piston speed. If this is the case with a stationary engine, why should it not be equally true for a locomotive? For long distance runs a $5\frac{1}{2}$ feet whee would be an advantage if the grades were low; with heavy grades the 5 feet wheel would give best results.

The details for a fast locomotive should be carefully worked out. Large steam pipes with few turns, valves with a large cavity, and a free discharge from exhaust should be provided. The Allen valve will be found very effective. The boiler should be fed with injectors; pumps with an engine of this class are a constant annoyance, and time is frequently lost from their failure to work. Large bearings, with cups to freely lubricate for the whole run, should be provided. The parallel rods should be of steel, and made as light as

possible; a large per cent. of parallel rods break because the
too heavy. Lastly, it should be borne in mind that a locom
with a given sized cylinder, boiler pressure, and weight on dri
will haul a given number of tons at a given speed. When the
is greater, with the same conditions, time will not be made.

The moral of this is, do not put more cars in the train thai
engine will haul and make schedule time.

Yours truly,

JAS. M. BOON, *M.*

Report of Mr. Francis M. Wilder as to Best Form of (struction of Locomotives for Fast Passenger Service

WM. WOODCOCK, ESQ., *Chairman Committee to inquire as to Best Form of struction of Locomotives for Fast Passenger Service, Master Mech Association.*

DEAR SIR — In reply to your letter inquiring as to the Best
sign of Passenger Locomotives, I would say that I think there i
difficulty in running at an average rate of speed of 50 miles per
with almost any of our eight-wheeled American locomotives, ha
driving wheels 5 feet 6 inches and over.

The problem is one which depends for solution upon many
tingencies, viz.: the condition of the track, grades, curves, weig
train, etc. I believe that the locomotives of our American pat
having driving wheels 5 feet 6 inches diameter, with 18 by 22 in
cylinders, with 5 inches throw of eccentric, steam-receiving
1 by 16 inches, exhaust ports $2\frac{1}{2}$ by 16 inches, valves having $\frac{7}{8}$
outside lap, no inside lap, with about $\frac{1}{16}$ inch lead; with bo
suitable to generate steam to supply the cylinders, working s
inches with a full throttle, would have no trouble on a level ro
drawing five coaches at an average rate of speed of 50 miles per h

How long the engine will endure to run at that high rate of sp
depends almost entirely upon the condition of the track. If
joints of track are all kept in good condition there will be no tro
from excessive cost of repairs, even at such a high rate of speed
append hereto statement of boiler dimensions which I think
ample to fill these conditions. I do not think that the weight o
drivers should exceed 12,000 pounds to each wheel. You will
very good results from using broad wheel centers, say 8 feet 6 inc

which gives ample room to put in desired length of fire box; total wheel base 22 feet, with swing beam truck.

On this road we have no trains denominated "Fast Passenger," although we have trains with schedule time of 34 miles per hour for 428 miles, which have to run from 40 to 45 miles per hour to make their schedule time on account of the long stops.

In regard to fuel I prefer bituminous coal, as I consider that more reliable than anthracite coal where a long steady fire is to be kept up.

We have had no experience with engines having only one pair of driver wheels in running passenger trains. There is no doubt at all that if your train is light enough, so that enough adhesion can be obtained without excessive weight, one pair of driver wheels is preferable; but that is very hard to do.

I consider that after you have arrived at the point where the tire and rails receive a certain permanent set at their point of contact, which, though it be very little, after awhile the metal near the surface of the rails and tire loses its cohesion and both laminate and peel off.

I think 12,000 pounds is a perfectly safe weight to apply to a single driving wheel, while 16,000 pounds will give a weight which is above the elastic limit of the material. There is no doubt at all if you apply a weight which is greater than the elastic value of the material the value of the factor for adhesion is largely increased, as the tendency is to tear the rails and raise up little points which will interlock each other like teeth, for that reason I think that it is necessary in passenger engines to keep the weight below 12,000 pounds per driving wheel. I have found by dynamometer experiments, which I have made, that about 22 per cent. of the weight upon driving wheels (12,000 pounds to each wheel) can be relied upon as tractive force, which can be exerted on ordinary good rails; *i. e.* with an engine having 24,000 pounds on driving wheels we might expect that we could get 5,000 pounds traction force to apply to driving on the train. This would be sufficient for light passenger trains, say a train of from 4 to 6 cars, after they have started, but would not be nearly sufficient for starting them away from stations promptly, and would only be reliable for trains of from 2 to 3 cars.

In conclusion I would say that with trains of from 2 to 3 cars, weighing about 120 tons, I think an engine with one pair of driving

wheels, and a weight of not over 12,000 pounds to each wheel, having say 16 by 24 inches cylinders, driving wheel centers 6½ or 7 feet, would probably be the best engine that could be used. Then, if your trains should necessarily consist of 5 or 6 cars, weighing from 200 to 250 tons, your engine should be an eight-wheeled connected engine, having 18 by 24 inches cylinders, with 6 feet driving wheels, with a weight of say 12,000 pounds upon each driver.

I have had very little time to consider the subject further than your inquiry has brought it to my mind, and I regret that I could not have given it more attention.

Dimensions.

Size of cylinder	18 inches diameter, 22 inches stroke.
Diameter driving wheel	62 inches center, 68 inches outside of tires.
Weight on drivers	48,000 lbs.
Size of boiler	50¼ inches outside diameter, smallest course.
Size of fire box	73 inches long by 34¼ inches wide inside of water space frame, and 66¾ inches high from bottom of frame to under side of crown sheet.
Number, diameter, and length of flues	168, 2 inches outside diameter, 137 inches long between tube plates.
Heating surface	flues, 1,003 square feet.
Heating surface	1,109 square feet.
Driving wheel base	8 feet 6 inches.
Total wheel base	23 feet.

I subscribe myself, very truly yours,

FRANCIS M. WILDER.

It was then voted that the report be received and printed in the records of the Association, together with the accompanying letters.

THE PRESIDENT—It being very nearly time for the discussion of special subjects—the hour between 12 and 1—I would suggest that we now take a recess for ten minutes to enable our Finance Committee to receive the dues of the members. The Finance Committee is present—Mr. Richards and Mr Woodcock—and they will attend to that duty.

[A recess was then taken.]

After the recess the President stated the next hour would be spent in discussing any subjects that might be brought up by members of the Association, if any gentleman had any special subjects they would like to bring before the Convention.

Mr. SCHAEFFER, Louisville, Cincinnati & Lexington Railroad—We were speaking about the increase of speed, and in the report of our Committee we have some facts which we can improve upon in many ways if we go

into the details. I think the counterbalancing of our engines are not quite perfect enough; there is not sufficient uniformity, and I must be wrong, or some others must be wrong; I think to increase the weight of the counterbalance too much increases the liability of wheels to break. To ascertain the correct weight of the counterbalance is what we want to get at, and, I think, a committee should be appointed for that purpose, to report next year, to give us a practical view of this question. There may be some device that can be put up in the shop, as has often been done, to ascertain the exact weight of the counterbalance which is best, so we can get rid of all unnecessary dead weight in calculation. In connection with this I would like to have a report on injectors, as a great many different ones are in use in this country. I would like to have a committee to report which is the most desirable.

THE PRESIDENT—I think it will be impracticable to have a committee investigate the injector question, and report as to the comparative merits of the different kinds of injectors used by parties in this country. It will put the Association in a position that I hardly think we would care to occupy; *i. e.* to have a committee indorse any particular make of injector. That matter has been brought up a good many times, and we have uniformly refused to indorse, by word or act, any particular patented article. I think we had a committee at one time that made elaborate tests as to the comparative merits of injectors and pumps. I think Mr. E. T. Jeffreys, of the Illinois Central Railroad, made some experiments, and the committee made an elaborate report, which showed conclusively that the injector was very much superior to the pump in several respects. I think we had better let the injector matter remain where that report left it, and leave members free to adopt any particular injector they see fit. You can readily see that if the Association should make recommendation it would lay us open to criticism from parties interested in other injectors.

Mr. SCHAEFFER, Louisville, Cincinnati & Lexington Railroad—I do not mean that the committee shall decide as to the respective merits of the various injectors; but by an investigation of the subject, and make a report upon it, we would learn something by knowing what a certain injector had been doing, what the fuel has been, the amount of repairs, etc. I did not mean for them to make a report that would hurt the feelings of any one.

Mr. HAYES, Illinois Central Railroad—I would say to Mr. Schaeffer that those experiments in Mr. Jeffrey's report were made under my eye, and my recollection is that the saving of the injector in fuel over the pump was about 7 per cent. We arrived at that conclusion by running the engine for a month, weighing the cars and all the fuel used, and also the water evaporated. Then we took off the injector, and run the engine with a pump for a month, weighing the cars, the coal, and the water, and we found, as I have said, a saving of about 7 per cent. in favor of the injector. The cost of the repairs of that particular injector, for the period in which those experiments were made, was the cost of one throttle valve.

THE PRESIDENT—At this time I would remind the members that all questions on which committees are to be appointed to investigate for the coming year should be referred to our Committee on Subjects. We appointed the committee last year—one member to hold his place three years; one two years, and one one year, so it will be necessary this year to elect one new member on that Committee. That Committee is composed of James M. Boon, for three years; Jacob Johann, for two years, and S. A. Hodgman, for one year. Mr. Hodgman has served one year, and we shall now have to elect another member on the Committee. If any one has a subject that he would like to have a committee appointed to make a report on, he can communicate it to the Committee on Subjects, and if the Committee think best they will recommend that subject to the Convention.

A MEMBER—I would like to have a committee appointed on smoke. Up in the Cumberland Mountains we are using bituminous coal, and we are troubled a good deal with the smoke. The officers of my road want to know if we can not burn the smoke; and, also, that we ought to do something with the sparks. We have palace cars, and the passengers riding over the road in them do not want to be bothered with the smoke and sparks which now annoy them greatly. I think a committee on sparks and smoke would be a very good committee.

Mr. SETCHEL, Little Miami Railroad—Mr. President, if Mr. Schaefier will look over some of our previous reports he will see that there has been a committee report on counterbalancing; and the gentleman who has just spoken will find, if he looks over the reports, that there has been, I think. three or four reports from committees on the burning of smoke, or the economical consumption of fuel. There is one in the report of last year. I have just been handed a question by Mr. Woodcock, viz.: "What is the Best Lagging or Covering for Locomotive Boilers, and the Best Means of Applying the Same?" That, as I understand it, Mr. President, is a question submitted under the rules for discussion at this time.

Mr. WOODCOCK, Central Railroad of New Jersey—I merely put that in to awaken some little inquiry. My object was to know whether we are using the best arrangement for covering boilers. Wood is principally used, I believe, and there is a great deal of difficulty in keeping that wood in shape at least we find it so; and I want to know whether any one has made any experiments, or had any experience, with any thing else besides wood, or whether we can get any thing any better than wood. Our manner of applying lagging on the boiler is, in the first place, to fasten the hoops round the boiler and attach the strips of wood lagging to them; but, in time, the hoops becomes charred, and the lagging naturally drops down and causes trouble. Frequently the wood takes fire, and it burns underneath. Now, if there is any thing better I would like to know it, and I raise this question to get that information.

Mr. SETCHEL, Little Miami Railroad—I have never tried anything bnt the plan Mr. Woodcock speaks of, and I find the same difficulty. It is diffi-

cult to make the wood retain its place. The hoops burn off, and the wood sinks down, and makes a bad appearance of the jacket, whereas if some more substantial material was used it would certainly improve the appearance of the engine; but whether it would be more economical or not is the question. A number of years ago our superintendent made a contract with a man to cover a boiler with some kind of asbestos, with the understanding that if it should show a saving in a year's time over other engines doing the same kind of work we would pay for it. The engine was running a local freight, and there were three engines of the same class doing the same work, running over 120 miles of road four trips a week. From some cause or other, although I do not feel disposed to attribute it to that, yet the engine did not make quite so good a showing as the other two; and when we came to have the bill submitted we exhibited the record to the gentleman. His bill, I think, was about $75 for the boiler, while the cost to us for wood covering was less than $15, and the engine not doing as well; that is not showing as good results; of course we felt as though we could not pay the bill, and did not. So far as my experience goes I have never seen any thing that has given better results than wood applied as Mr. Woodcock speaks of; but I would like very much to know whether there is any thing better and that will prevent the liability of fire under the jacket.

Mr. Flynn, Western & Atlantic Railroad—I will state for the information of members, that in South Carolina they are using a composition made of earthy or clayey material, called kaoline, which is put about the usual thickness on the boiler, and I hear they are obtaining very good results from it. The Master Mechanic is an Eastern man, who has been South for a number of years and been on that road two years. I did think of writing him in regard to it. There is certainly no trouble from fire in using this composition. That is the main difficulty with us in the use of wood, the lagging catches fire and the jacket becomes more or less defaced. Wood is the only thing I have seen, and I have tried several articles, that will answer my purpose. How this kaoline is put on I do not know. One of the engineers was up to see me some three months ago, and told me he was using it. It makes a very smooth appearance on the jacket, and they have no difficulty, and he thought the engine seemed to be doing better. If there is any committee appointed upon that subject it will be well for them to look into the merits of kaoline, and they may get some information that will be valuable.

Mr. G. A. Coolidge, Fitchburg Railroad—For the information of Mr. Woodcock I would say there are several preparations which I think are very good. In regard to the use of wood, I think he will derive great benefit by putting under the wood a preparation of asbestos, which comes in different thicknesses. I have used one sample about a sixteenth of an inch thick. It is a good non-conductor. I think it will make the wood endure very much longer. We have I can not say now how many, but a great many of our engines are covered with different preparations; what I consider the better one was originally known as the "salamander covering." It was

composed principally of asbestos, and I presume some lime and some plaster of Paris, and sometimes another substance was added. This was first applied about the year 1870, and after about ten years' service I removed the iron jacket on the inside and examined it, and found it all remained there intact, perfectly smooth, and the jacket was also in perfect condition; there had been no corrosion at all. In regard to the protection of the boiler, that is, the prevention of irradiation, I think it is fully equal to wood. Of course we all know that there is no better, at least I consider that there is no better, non-conductor than what is termed an "air space." With this method of covering, after it became fully dry, with a pressure of 100 pounds, I found I could put my hand or my cheek against the boiler without any discomfort. After the jacket is put on the iron becomes hotter than that; but while the iron is apparently somewhat hotter than it is over a wood covering, I do not know that the radiation is any more. In regard to the durability of these coverings we get the very best results. These locomotives I first referred to have been covered upwards now of eleven years, and all are in a perfect state, and the jacket is as smooth as when first applied. Some one may ask the question, how is it in regard to repairs and examination of the boiler? It is very convenient, by simply removing a section of the jacket. Since the time I applied this covering there have been several other appliances introduced, some of them I can hardly recommend. They are composed largely of clay; partially, perhaps, of cement. At the present time we are using a preparation of asbestos, the cost of which is about $60 a locomotive boiler. The cost of applying this when it was discovered was so much per square foot one inch in thickness, making the total cost at that time slightly in excess of $100; but, taking into consideration the number of years it has worn, I think it is very economical; but one of the best features of it is preventing fires. As every one knows, with wood-burning engines and even with coal-burning engines, there will occasional cinders get in under the jacket, and the wood takes fire and it becomes reduced after a while to nearly the consistency of what we call tinder, and ignites very readily, becoming a great nuisance, making a great loss, and detracts very much from the appearance of the engine. I have watched these appliances very closely, and with these two or three I see no bad results whatever; in fact, they are very satisfactory indeed. We have made no accurate experiments to determine the amount of radiation, but as far as the results can be arrived at by weighing the fuel there is no loss, and I do not know that I can say there is any great gain in that direction, any more than that the boiler is perfectly covered. I would recommend to any one who has an interest in the matter to try either one of those preparations; of course any preparation that has in its composition a large amount of asbestos is preferable.

The President—Our Constitution requires the Report from the Committee on Subjects to be presented at one o'clock on the second day of our session, and it being about the time we will hear the Report of the Committee on Subjects.

List of Committees and Subjects for Discussion at the next Annual Meeting.

To the American Railway Master Mechanics' Association:

GENTLEMEN — The Joint Committee appointed to report upon Committees and Subjects respectfully beg leave to report the following.

J. H. SETCHEL, *Secretary Joint Committee.*

I.

Committee on Research.

Improvements in Boiler Construction. Continued.

II.

Committee of Investigation.

The Best Material and Form of Construction for Parallel Rods of Locomotives to Prevent their Breaking.

HOWARD FRY, *Chairman.*

III.

New Plans of Construction and Improvement of Locomotive Engines.

W. WOODCOCK, *Chairman.*

IV.

The Most Practicable and Best System of Paying Premiums to Locomotives Engineers and Firemen to induce Economy in Working Locomotives.

F. M. WILDER, *Chairman.*

V.

Standard Wire Gauge Committee to Investigate and Recommend a Suitable Standard Wire Gauge for Adoption.

R. H. BRIGGS, *Chairman.*

VI.

Smoke Stacks and Spark Arresters.

JAMES SEDGLEY, *Chairman.*

VII.

Associate Members to Read Papers.

P. H. DUDLEY, Cleveland, Ohio;

HENRY MORTEN, Hoboken, N. Y.

It was voted to receive the report and adopt its recommendations.

Additional Committees Appointed.

VIII.

Committee on Conference.

Committttee to Confer with the Master Car-Builders' Association as to Time of Meeting.

F. M, WILDER, New York, Lake Erie & Western;
JAMES SEDGLEY, Lake Shore & Michigan Southern;
W. WOODCOCK, Central of New Jersey.

IX.

Standing Committee on Subjects.

JACOB JOHANN,	1 year.
JAMES BOON,	2 years.
J. H. FLYNN,	3 years.

X.

Trustees Boston Fund.

J. N. LAUDER, Northern of New Hampshire;
JAMES SEDGLEY, Lake Shore & Michigan Southern;
R. WELLS, Louisville & Nashville;
S. J. HAYES, Illinois Central;
J. H. SETCHEL, Little Miami.

XI.

Arrangements for the Next Annual Meeting.

F. M. WILDER, New York, Lake Erie & Western;
JAMES SEDGLEY, Lake Shore & Michigan Southern;
JOHN ORTTON, Canada Southern.

The President then read the constitutional provision in Article V, Section 6, relating to the joint meeting of the Advisory Committee and Committee on Subjects, and appointed the time and place for said meeting in the afternoon. The discussion of the paper "On the Best Form of Construction of Locomotives for Fast Passenger Trains" was postponed until 9 o'clock Thursday morning.

Mr. SETCHEL, Little Miami Railroad—Mr. President, I regret exceedingly to be obliged to say to the Convention that in my record I have omitted to mention the death of one of our members, and I am more pained to make the acknowledgment from the fact that he was a man whom I knew very well, and who had run for me for a great many years. That is Benjamin Gregg, of the Cleveland & Sandusky Road; a member that attended our last meeting and the meeting of the Master Car Builders. On going home he

was taken sick immediately thereafter, and never left his bed. When the committee on the death of Mr. Swift is appointed a committee can be appointed in the case of Mr. Gregg also, and their report can be incorporated in the minutes as has been previously done.

THE PRESIDENT—When that committee is announced we will include both of those late members. I would have been glad to have mentioned the matter in my Address if I had known of it, but it will appear in our records when printed.

The President then announced the following as the Committee on Place of Meeting: Augustus Schaeffer, Louisville, Kentucky, L., C. & L. R. R.; Charles H. Corey, Portsmouth, Ohio, S. V. R. R.; John H. Flynn, Atlanta, Georgia, W. & A. R. R.

The Committee on Resolutions was named as follows: J. W. Philbrick, Waterville, Maine, M. C. R. R.; J. F. Devine, Wilmington, North Carolina, W. & W. R. R.; R. H. Briggs, Whistler, Alabama, M. & O. R. R.

The Secretary then read the following paper on Shop Tools and Machinery for the Manufacture of Locomotives, submttted by H. N. Sprague, Chairman of Committee.

Shop Tools and Machinery.

To the American Railway Master Mechanics' Association:

Your Committee appointed at the last Annual Convention to report on the subject of Shop Tools and Machinery, issued the following

CIRCULAR.

To Members of the Master Mechanics' Association:

The undersigned, your Committee on Shop Tools and Machinery, respectfully solicit replies to the following questions:

1st. To what extent are you milling work, and what parts of loco, motive work, in your judgment and experience, is it advisable to mill and for what reasons?

2nd. Do you use any machines other than the ordinary slide lathe for making and threading bolts, set screws, or studs? If so please describe them or give maker's name, and state the advantages.

3rd. Are you using grindstones, emery wheels, or belts for finishing work? If so please state on what kinds of work and the advantages it possesses over ordinary practice.

4th. To what extent do you use dies and formers in smith shop, and with what advantages?

5th. Have you in use any improved machinery or any special tools (however simple) not in general use, that improves or econo-

mizes work? If so please give maker's name, or if special describe, and, if possible, send drawings and state advantages.

Owing to the newness, extent, and importance of this subject we earnestly solicit your careful consideration of these questions, and as full information as possible.

Replies to be sent before April 1st, 1881, to H. N. Sprague, of H. K. Porter & Co., Pittsburgh, Pa.

H. N. SPRAGUE, *of H. K. Porter & Co.*,
N. E. CHAPMAN, *C. & P. R R.*,
D. A. WIGHTMAN, *Pitts. Loco. Works*, } *Committee.*

To this circular we have received only five replies, as follows:

Question 1st. Mr. J. M. Boon, Pittsburgh, Fort Wayne & Chicago Railroad, and Mr. P. I. Perrin, of the Taunton Locomotive Works, report using milling machines to a considerable extent and think it desirable to extend its use. Mr. R. H. Briggs, of the Mobile & Ohio Railroad, reports using it for tool work only. Mr. W. O. Hewitt, of the Toledo, Peoria & Warsaw Railroad, uses milling cutters in the ordinary lathe for tool work. H. N. Sprague, of H. K. Porter & Co., uses them on general work and finds especial advantages in milling rod brasses.

Ques. 2nd. One member uses turret screw machine for studs and bolts, two members use the center bolt cutter, others the common bolt cutter and lathe for threading bolts and studs.

Ques. 3rd. Three report using grindstones and emery wheels, and belts for finishing work to a certain extent. J. M. Boon and H. N. Sprague consider a shop incomplete without them.

Ques. 4th. They all report the use of dies and formers in smith shop, and consider them essential. J. N. Lauder sends drawings of a power former for bending truck irons and similar work, apparently possessing commendable features which is submitted for your inspection and disposal. Mr. Briggs, of the Mobile & Ohio Railroad, submits drawings of machines for forming and clamping work, which are patented, but are submitted for inspection.

Ques. 5th. Mr. G. W. Cushing, of the Missouri, Kansas & Texas Railroad, sends drawing of gauge for measuring thickness of tire at point of contact of rail, also a device to attach to planer for dressing the circular seat for journal brasses. H. N. Sprague, clamp for ratchet drilling on boilers.

Your Committee confess to disappointment in the number of

replies received, and especially in answer to question five, as they are persuaded that there are many little special devices used by various members that would be of great value to all, but from their very simplicity are probably overlooked. We have endeavored, by considerable correspondence, to urge on and ascertain how far the tap and die makers have advanced in their attempts to reach an interchangeable standard, but have received no definite information; we trust, however, that some results may be reported at our Convention. We are, however, convinced that the trifling inaccuracies among standard makers are so insignificant, as compared with the variations sure to arise in the ordinary practice of making them in different shops, often with inferior machinery; and in view of the importance of interchanging bolts and nuts in the present plan of operating railroads, we earnestly recommend to the members the advantages of buying all of their taps for standard work. We had thought that it was proper to confine ourselves to the present standard tools in general use, endeavoring to draw out and compare the practice of different members with a view to improve present methods and calling attention to the advantages to be gained by properly utilizing present tools, and indicating in what direction the advance should be for special tools and improved methods of work; and, although we have come to so "lame and impotent a conclusion" in this meagre report, we feel that the leaven is working, and would recommend that the subject be continued with a more *efficient* Committee, confident that great improvements can and will be made, and that it is our interest as well as duty to encourage and help them in the interest of economy in our departments, and also in the interest of mechanical advancement.

Respectfully submitted,

H. N. SPRAGUE, *of H. K. Porter & Co.*,
N. E. CHAPMAN, *C. & P. R. R.*,
D. A. WIGHTMAN, *Pitts. Loco. Works*, } *Committee.*

[A large number of drawings accompany the foregoing report, which, if the Association should engrave, would entail a great expense, which the Committee deem unadvisable, especially as most of them are patents.]

By vote the paper was received.

THE PRESIDENT—I shall be glad to hear from you, gentlemen, in regard to improved methods of doing shop work, although it is so late that we can not discuss the subject very much. There is hardly any of us but does some one thing better than our neighbors; and if my neighbor is doing some par-

ticular thing better than I am, I shall be glad to know it, and also how he does it. I answered the Committee's circular, and sent them a drawing for a very efficient arrangement for bending the arch bars. That, however, comes more properly under the car department than the locomotive, although the same thing is used largely on tender trucks. I presume the drawing will appear in the Annual Report. That is the only thing I can mention which, I think, I am doing better than my neighbors. I saw the necessity of having some improved method for bending those arch bars, and this machine was constructed at our own shop, and proved to be what we wanted.

On motion of Mr. Hayes, the Convention then adjourned until Thursday, June 16, at 9 o'clock.

THIRD DAY'S PROCEEDINGS.

The Convention was called to order at 9 o clock, Thursday A. M., June 16, 1881.

THE PRESIDENT—The special order of business assigned for this hour is the discussion of the report read by Mr. Woodcock, of the Central Railroad of New Jersey, on the Best Form of Construction of Locomotive Engines for Fast Passenger Service. That question is now open for discussion. It is an important subject, and was treated thoroughly by the Committee, but I should presume it might raise some question in the minds of members. If any gentleman have any points they wish to present concerning it I shall be very glad to hear them.

Mr. G. A. COOLIDGE, Fitchburg Railroad—Mr. President, I think that the subject might be divided under two heads. As I understand, there are two classes of fast passenger locomotives; one, perhaps, to be used for light trains, and the other for heavy trains; and the report of the Committee seems to have covered them both. A locomotive that would be adapted to draw ten or twelve heavy coaches, weighing from twenty to thirty tons, would require too much weight for adhesion to put on one pair of drivers; whereas, in running light trains of four or five cars, one pair of drivers would be sufficient, so, I think, the subject might better be considered under two heads rather than one. It seems to me there is an element of safety in what may be called the new type of locomotive, which has but one pair of driving wheels. We all know that there have been some very serious accidents resulting from the breakage of parallel rods and crank pins. One may say it is possible to make the parallel rods so that they will not break. Very true. Then there is the liability of the breakage of the crank pins. We all know that it is usually the back crank pins which break first. I was very much impressed many years ago by a practice of one of our old members, familiarly

known as Dr. Williams, Superintendent of the Pennsylvania Railroad. At that time they were using a large number of Mogul engines, and, I think, their principle was to make the main rod connection on what was called their "standard engines" on the outside. I think that lessened the liability very much of the breakage of the back crank pins, and, perhaps, that would partly remedy the difficulty I mentioned. Others may not think so; but, as I view the matter, it will be somewhat difficult to construct an engine and wholly avoid the liability of parallel rods and crank pins breaking on the extreme fast service like that which most of us are familiar with. On the Pennsylvania Railroad, between New York and Philadelphia, they have attained to nearly sixty miles an hour, and we might safely say that there is less liability to the breakage of parallel rods and crank pins by having that type of engine, and seemingly it is the only way in which absolute safety in that direction can be maintained; but for service, where the trains are heavier, on steep grades, it would seem necessary and essential that we must have an engine with more adhesion, which means more weight. I shall be very glad to hear the opinion of any other members on this matter. We are all working for one point at least—that is safety. I know the demand for high speed is great, and the public demand luxurious cars, which entail great weight. To draw those cars requires great power. Power means heavy locomotives; but we must not forget the element of safety.

The President—The gentleman who has just spoken (Mr. Coolidge) has alluded, I think, to a principle that was at one time quite extensively used on the Pennsylvania Railroad, and I do not know but that it is still—in fact, I think it is—of spreading the cylinders and fastening the crank pin on the outside of the hub of the wheel, connecting it the same as the Mogul, which was done as long ago, I think, as 1860. I think Mr. Laird, who was then Superintendent of the motive power of the Pennsylvania Railroad, was the first man to do that. That was done to avoid the difficulty of the pins and parallel rods breaking. I think that system has been continued on till the present time, but I am not sure. It is something that is well worthy a little thought. With the long, heavy engines we now build, there is no practical difficulty in spreading the cylinders wide enough to have the connection take hold of the pins outside the parallel rods. In practice it is no detriment to the engine, and it seems to me that inasmuch as the back pin on the ordinary eight-wheel engine is usually the one that breaks, that a parallel rod put on in that way is less liable to give trouble. I think that a little careful investigation of this question in reference to putting it close to the wheel should be made before we condemn the eight-wheel engine for passenger service. My impression is the eight-wheel American engine, so-called, is the engine for passenger service. I thoroughly believe in it. We have adhesion enough, and I think the question of safety in parallel rods and crank pins is purely a mechanical matter. I think they can be made absolutely as safe as the tires or any other part of the engine. You can make the pin a foot in diameter if you desire. It is different with

the coupling rod. If that is improperly proportioned, the heavier you make it the worse off you will be. There is more importance in proportioning the parallel rod rightly than there is in the metal put in it. We have this as one of the subjects to be investigated and reported on at the next meeting, and I hope the committee will investigate the matter fully, and present to us at the next Annual Meeting a design for a parallel rod that will be much better than any thing we have yet used.

Mr. R. H. Briggs, Mobile & Ohio Railroad—Mr. President, I have heard a great deal about parallel rods breaking, and in the course of my experience I have seen a great deal of it, but I must say on the fast Western trains I never saw any break yet but what was due to some defect in the mechanical construction. Now, in the first place, we want a parallel rod for a fast passenger engine. We all know that the vibration on a parallel rod is great with the wheels small. Suppose we build a passenger engine for extremely fast service, and make the wheels sufficiently large to reduce that vibration according to the number of turns the wheel makes, and then make a cylinder large enough to turn the wheel. Now, it looks to me as though the first thing is the boiler, then the cylinder, and then the wheels. If I want to make a mile a minute with a five-foot wheel, I have got extraordinary work for the machinery; but if I want to make a mile a minute with a seven-foot wheel, it reduces the amount of work the machinery has to do. It seems to me, from the experience I have had (and I have been railroading for many years), that the breaking of the parallel rods is because of your taxing the engines with more than they can bear. I recollect instances of engines breaking down on a road not far from me. They were required to do extraordinary fast work, and in every instance, where those parallel rods broke, it was due to the fact that the engine was constructed mechanically wrong. The crank pins were out of shape, the wheels were defective, the wedges were down, and the engine was expected to do heavy work, and so the parallel rod broke I believe in every case. If this subject is thoroughly investigated, it will be found that the service required of the engine is too much, and in some instances the engine is constructed poorly; now, I think, if you take a six-foot wheel, and put the engine up square, and will put the pins up right and have her rods connected in the proper way, and put a cylinder on that will turn the wheel as it ought, we will get a slow motion to the machinery and speed to the engine with perfect safety for the result. As far as a single driver is concerned, in 1853 I ran a single driver engine on a flat rail, and it was the fastest engine in that part of the country, but it was seldom there was any thing behind her when she went fast; and that is about the case to-day. In fact, it is simply history repeating itself. Where are the single-driver engines that were expected to do such extraordinary service? I have not seen them yet. For some cause I think there is a very thick veil hanging over them. I think the truth of the matter is this, we do not want to get too small a driver, and we want a good-sized cylinder and

boiler to make the driver do its work. I have run engines many years, I have had charge of engines many years, and I must say, gentlemen, and I do not say it in order to prove that I give better attention to my machinery than other people, but I have never had a parallel rod break with me yet; and I think the reason of its breakage is simply due to putting too much service on the engine. I think you, gentlemen, on these Northern roads, ought to take that matter into consideration, get a big wheel, a big cylinder, a big boiler, and then the parallel rods will take care of themselves.

THE PRESIDENT--I have noticed the welcome arrival of one of our Associate Members, Mr. M. N. Forney. Mr. Forney has always been one of our talking men, and we have missed him very much thus far in our Convention. For his benefit I will state the question before the house; possibly he may have something to say on this question. The question before the house for discussion is on the "Report of the Committee on the Best Form of Construction of Locomotive Engines for Fast Passenger Service." An elaborate report has been submitted by Mr. Woodcock. If Mr. Forney has any thing to say on the subject we shall be very glad to hear it.

Mr. M. N. FORNEY, of the Railroad Gazette, New York — Mr. Chairman, you take me a little by surprise, but the subject of engines for fast passenger service is one that I have thought of a good deal. My own conviction is that the difficulties of making an engine for drawing a heavy train at high speed are much greater than ordinarily supposed. The difficulty may be stated in this way. I suppose it is a fair representation of the facts to say that ten, or fifteen, or twenty years ago, the ordinary passenger trains consisted of about ten cars. There was not much difficulty in drawing those cars at an average speed of thirty miles an hour with an engine of 16 by 24 inches cylinder and 5 or 5½ feet wheel, a fire box 5 feet long and a boiler with about 850 to 900 square feet of heating surface. Now the problem that is presented to railroad men is to draw trains of fifteen cars, and draw them at the rate of forty-five miles an hour instead of thirty. At first sight it seems as though that would require a comparatively slight increase in the power of the locomotive, but if you will calculate the number of foot-pounds, that is, the amount of work done in an hour, it will be found that it is just about three times the amount of work required of the present engine that was required of the old engine at the old speed. Now, if you exert three times the amount of work, you need a fire-box grate three times as large, and you should have about three times as much heating surface. In other words, the grate would require to be about 15 feet long; you ought to have about 2,700 square feet of heating surface. The difficulties of meeting this requirement are so great that whenever the attempt has been made it has almost universally failed. It is true engines have been built which, under favorable circumstances would take those trains at this speed, but whenever the circumstances became unfavorable they failed; therefore I think the object we must aim at, if we want to pull trains at the speed named, is an increase of the capacity of the engines. We must increase the adhesion over that of the

old engines, which is about 40,000 pounds. We need an engine with about 80,000 pounds of adhesion, and about 4,000 square feet of grate area, and about 2,700 feet of heating surface. Of course it will be said that would be an enormous engine, but I do not see how we can do the work unless we have an engine of some such character as that. You, gentlemen, know more in your practical experience about the difficulties of doing the work than I do, whether the engines fail from want of steam or want of adhesion, or for want of practical power. My own conviction is from observation that the chief trouble is want of steam, and my impression is that there will be a radical departure in the construction of engines for that service before a great while. Then there is another question which arises. If we are to have 80,000 pounds of adhesion, we must consider how much we can put upon one wheel. I doubt very much whether the superintendents of railroads will permit, under existing circumstances, a load as high as 20,000 pounds per wheel, which would be necessary with an adhesion of 80,000 pounds on four-wheeled engines; but if we can not put 20,000 pounds on each one of the four wheels, the next conclusion is that we must have more wheels. Before this Convention met I undertook to make some plans, a sort of ideal passenger engine. I hoped to present it to the Convention, but there was so much other work to be done (as I expect to leave the country soon) I did not have time to prepare that paper; possibly I may do it before next year. My impression is the future passenger engine will be an engine with six driving wheels; that there must be a radical change in the construction of the fire box so as to get the requisite area without increasing its length unduly. We shall need a boiler from 54 to 62 inches in diameter. My impression is we will have to fill the whole barrel of the boiler with steam tubes; the boiler will need to be lengthened and the fire box considerably wider than the one now in use. The latter part will of course involve some very important changes in the construction of engines, and is one which Master Mechanics and locomotive builders can bother their brains about.

Mr. WIGGINS, Houston, East & West Texas Railroad — I move this discussion be closed.

Carried.

The PRESIDENT — The next business in order, gentlemen, will be the reading of a paper prepared by one of our Associate Members, John W. Hill, of Cincinnati, Ohio. The Secretary will read it.

The Secretary read the paper, as follows:

The Quality of Steam.

BY JOHN W. HILL, Mechanical Engineer.

To the American Railway Master Mechanics' Association:

GENTLEMEN—Experience has shown that steam always carries a certain percentage of water in suspension as it rises from the body of water from which it is formed. This percentage will vary

as between different forms of boilers and the same boiler operated under different conditions. The water so suspended in the steam is known as water entrained or as primage.

The raising of the water in a boiler by induction, when a large steam pipe is suddenly opened, is entirely independent of the water entrained, and is not meant by any allusion to primage in this paper.

I believe it is a fact observed in chemistry that anhydrous gases can not be obtained by direct vaporization, and that a special drying process is necessary to saturate or remove the liquid always entrained in the gas upon its first formation.

Saturated steam (that is steam charged with such an amount of heat that any reduction thereof would produce condensation, and any increase thereof would produce superheat) is substantially a perfect gas, and is usually so considered in all formulæ upon its action in a steam engine.

Our best information upon the temperature (heat) of saturated steam at various pressures is from the experiments of "Regnault's" Comptes Rendus, 1847, with which all steam engineers are sufficiently familiar to avoid the description of his apparatus, or the circumstances under which his experiments were made, at this time. It is proper to state, however, that the experiments of "Regnault" were to ascertain the relations of temperature, pressure, and density of steam, and as a corollary to determine the specific heat of steam and water at various boiling points.

The determination of the relation of densities and pressures was never made by "Regnault;" the only recorded experiments upon which were by Messrs. Fairbairn and Tate several years later.

It is now well known that the steam engine is a heat engine, that the water which is vaporized to form steam is simply a vehicle in which we store up the heat in the boiler, and which parts with a portion of the heat in transit through the engine, partly by conversion of heat into work, partly by conduction and radiation through the walls of the cylinder, and partly by the cooling effect of the atmosphere on the piston rod.

No steam is expended in operating an engine, for the same weight of water as vapor which enters the cylinder of the steam pipe also leaves the cylinder by the exhaust pipe. If we deliver one thousand pounds of steam at a given temperature to an engine through the steam ports, we shall draw off through the exhaust ports pre-

cisely the same weight of steam at a lower temperature; but, during the passage of this steam through the engine, a certain reduction of temperature has occurred, and the efficiency of the engine is a function of the limits of temperature between which the steam enters and leaves the cylinder, as enunciated by the junior Carnot more than fifty years ago.

To illustrate the efficiency upon the heat basis let us suppose an engine condensing and consuming 16½ pounds of steam per hour, connected with a battery of boilers furnishing ten pounds of steam per pound of coal from the temperature of feed; let the thermal value of the coal be taken at 15,000 units, and estimate 75 per cent. of this, or 11,250 units as contained in the steam above the temperature of feed water; then the efficiency of such an engine would be

$$\frac{11{,}250 \times 1.65 \times 772}{33{,}000 \times 60} = 13.82 \text{ per cent.},$$

or of every 100 horse power resident in the heat expended in working the engine less than 14 are utilized, the remaining 86 horse power going out in the exhaust.

It is well known that the best economy we have any record of has been obtained from pumping engines, and that a duty of 100,000,000 foot-pounds per 100 pounds of coal is seldom obtained.

Now our condensing engine working upon 16½ pounds of steam, or $1\frac{65}{100}$ pounds of coal per hour, represents a duty of

$$\frac{33{,}000 \times 60 \times 100}{1.65} = 119{,}988{,}000,$$

nearly 120,000,000 foot-pounds, from which it appears that *fourteen per cent.* is about a maximum efficiency with our present knowledge of construction.

The object of this paper is, however, not to discuss the economy of steam machinery, but to show the necessity for an exact knowledge of the thermal value of steam in estimating the economy of engine and boiler performance. To illustrate the effect of a lack of knowledge of the quality of steam furnished by boilers, let us suppose a temperature of feed of 212° F., an expenditure of 1,000 pounds of coal, a consumption of 12,000 pounds of feed water, and a boiler pressure by gauge of 125 pounds. The apparent evaporation from the temperature of feed in this instance is 12 pounds of steam to 1 pound of

coal; without information to the contrary and in accordance with the usual practice, we would accept this as the evaporation, and pronounce the result extremely satisfactory. Suppose however the temperature of the steam, instead of being at saturation (1,221.53 units), contained as a mean per pound only 1,135 units, then the actual evaporation instead of being 12 to 1 would be only $10\frac{8}{10}$ to 1, and this instance supposes an efficiency of furnace and boiler of nearly 75 per cent., and a thermal value of 15,000 units per pound of coal; in brief, supposes a quality of coal and efficiency of furnace rarely obtained.

None of the usual devices applied to steam boilers are capable of measuring the thermal value of steam, and recourse is had to special apparatus for this purpose.

Two distinct forms of calorimeter have been used; one the continuous calorimeter, in which the condensation of a certain small percentage of the steam is maintained during the entire trial of a steam engine or boiler, and the other the intermittent calorimeter, with which at stated intervals known weights of steam are drawn from the boiler or steam pipe and connected in known weights of water.

The continuous calorimeter consists usually of a coil of brass or copper pipe of $\frac{1}{2}$, $\frac{3}{8}$, or $\frac{1}{4}$ inch diameter of bore, containing 30 to 50 lineal feet. This coil is placed within a tin can through which the circulating water passes from below upward.

The upper end of the worm is constructed with a steam pipe or steam drum of the boiler, and the lower end terminates in a neck which delivers the condensed steam into a receptacle mounted upon a carefully balanced scale, upon which the condensation is weighed from time to time and dumped.

The circulating or condensing water is measured by tanks of known capacity, or through a Worthington meter, the error of which is known by test.

Standing thermometers are located as follows: one in the injection nozzle, by which the circulating water enters the apparatus; one in the overflow nozzle, by which the circulating water leaves the apparatus, and one in the neck of the worm from which the water of condensation flows.

Should there be an indication from the calorimeter data of superheat in the steam, an additional thermometer should be inserted

in the head of the worm or in the steam pipe leading to it, to measure the superheat independently and check the record of the calorimeter.

Steam flows through the worm and is condensed, the heat being transferred through the walls of the coil to the circulating water.

The temperature of the circulating water is elevated through a range represented by the difference of temperatures of the inflow and outflow. The temperature of the condensation as it leaves the calorimeter is read from the thermometer in the neck of the worm. The temperature of the steam is the unknown quantity which we seek.

To illustrate the action of the continuous calorimeter assume a weight of steam condensed of 100 pounds, a weight of circulating water expended in condensing it of 2,000 pounds, a temperature of inflow of 50 degrees, a temperature of outflow of 105 degrees, and a temperature of condensation of 60 degrees, all on Fahrenheit scale; then temperature of the steam is

$$\frac{2,000 \times 55}{100} + 60 = 1,160° \text{ Fahr.}$$

Assume the steam as it entered the calorimeter at a pressure of 135 pounds by gauge, or 150 pounds absolute, at which pressure the temperature of saturation is, according to "Regnault," 1,223.18° F.; then difference of temperature is 63.18 units, indicating that a portion of the water was entrained in the steam.

To estimate the percentage of primage we must bear in mind that the water in the boiler is first heated to a temperature of 362.56° F. (corresponding to a pressure by gauge of 135 pounds) before vaporization takes place, and that an additional temperature of 860.2 units is necessary to vaporize the water so heated, and that the discrepancy in the thermal value of the steam applies to the temperature of vaporization, whence the water entrained, or primage, becomes

$$\frac{63.18}{860.2} = 7.35 \text{ per cent.}$$

The intermittent calorimeter consists of a water-tight vessel (preferably of wood to avoid transfer of heat to or from the contents by conduction and radiation) mounted upon a sensitive scale, into which a known weight of water to be heated is drawn.

A small steam pipe, usually three-quarter inch diameter, closely connected with the main steam pipe or steam drum of the boiler, dips into the vessel, and is provided with a cock or open way valve to regulate the delivery of steam into the weighed quantity of water. The temperatures are taken with a hand thermometer.

As suggested, a known weight of water is first weighed into the tank on the scale; usually some convenient quantity to estimate from, as one hundred or two hundred pounds, of which the probable condensation in the small steam pipe usually forms a part. The amount of condensation which will collect in the steam pipe between observations will vary with the quality of the steam, and must be blown out to clear the pipe before the weighed quantity of steam to be condensed is blown in.

The weight of water and condensation blown out of the pipe having been justified, the temperature of the contents of the tank is carefully taken with a reliable thermometer, and five or ten pounds of steam blown in and condensed. (The weight of steam condensed should be as large as possible with a limited temperature of the contents of the tank to obtain a high range of temperature, since errors of weight are less liable to occur than errors of temperature, and the greater the range of the mercury the smaller the effect of errors of observation.)

The desired weight of steam having been condensed, the flow through the pipe is promptly suppressed, and a second temperature of the contents of the tank is taken. The first temperature being deducted from the second, the difference represents the range of temperature of the previously weighed quantity of condensing water.

To illustrate the principle of the intermittent calorimeter let us assume the following data:

Weight of condensing water	100	pounds.
Weight steam condensed	5	"
Initial temperature contents of tank	60°	Fahr.
Final temperature contents of tank	115°	"
Range	55°	"

And temperature of steam is $\dfrac{100 \times 55}{5} + 115 = 1{,}228°$ Fahr.

Supposing steam as before, at a pressure (absolute) of 150 pounds, the difference between the quality in the illustration and the temper-

ature at saturation is 4.82 units, corresponding to a superheat as measured by thermometer of

$$\frac{4.82}{.475} = 10.15° \text{ Fahr.}$$

I have not detailed the construction and action of the two well-known forms of calorimeter with the expectation of adding any to your knowledge thereof, but to bring the processes fairly before you previous to calling your attention to some of the results of my experience with the instruments. I shall not attempt in the short time which by courtesy you allot me to detail all my experiments with the calorimeter, as these are many, and would frequently be simple repetition of results, but shall refer only to a few experiments to show the value of this class of investigations.

The first results we will examine are from a series of four experiments upon boilers set with smoke-preventing furnaces for the Cincinnati Industrial Exposition of 1879.

The first case was a return tubular boiler containing 963.64 superficial feet of heating surface, and worked at a capacity equivalent to 2.77 pounds of steam per foot of heating surface per hour, which gave a temperature of steam of 960.46 units, indicating with a pressure by gauge of 38.75 pounds, a primage of 26.26 per cent. The apparent evaporation from the temperature of feed (70.02° F.) per pound of coal was 7.59 to 1, but the actual evaporation was only 5.60 to 1.

The second case was a return flue boiler containing 519.45 superficial feet of heating surface, and worked at a capacity equivalent to 1.73 pounds of steam per foot of heating surface per hour, which gave a temperature of steam of 964.73 units, indicating with a pressure by guage of 80.29 pounds, a primage of 29.13 per cent. The apparent evaporation per pound of coal from the temperature of feed (166.01° F.) was 5.84 to 1, but the actual evaporation was only 4.14 to 1.

The third case was a battery of two return tubular boilers, containing 880.16 superficial feet of heating surface, and worked at a capacity equivalent to 3.20 pounds of steam per foot of heating surface per hour, which gave a temperature of steam of 1,005.93 units, indicating by a pressure by gauge of 76.18 pounds, a primage of 23.19 per cent. The apparent evaporation per pound of coal from

the temperature of feed (169.11° F.) was 9.69 to 1; but the actual evaporation was 7.45 to 1.

The fourth case was a direct tubular boiler containing 327.79 superficial feet of heating surface, and worked at a capacity equivalent to 2.96 pounds of steam per foot of heating surface per hour, which gave a temperature of steam of 1,441.35 units, indicating with a pressure by gauge of 81.60 pounds, a surplus heat of 18.83 per cent.

The apparent evaporation per pound of coal from the temperature of feed (74.55° F.) was 8.8 to 1; but the actual evaporation upon the basis of saturated steam was 10.56 to 1.

This boiler was set and worked simply for test purposes, and was furnished with superheating surface. The continuous calorimeter was used in these experiments.

The next results which I shall refer to are the calorimeter tests for quality of steam during the trials of steam engines at the Millers' Exhibition, Cincinnati, 1880.

In this instance the experiments were all made with the same boilers, operated under approximately the same conditions from day to day. The boilers, two return tubular, contained 1,327.24 superficial feet of heating surface, and were worked at the following capacities for six different trials: 2.53, 2.42, 2.32, 2.41, 2.42, and 2.63 pounds of steam per foot of heating service per hour, with corresponding temperature of steam of: 1,243.84 units, 1,211.3 units, 1,315.86 units, 1,255.74 units, 1,301.65 units, and 1,313.11 units. Of these temperatures only one, the second, indicates primage, all others exhibit a slight superheat.

The primage at 92.54 pounds pressure by gauge in the second experiment was (.46), or less than one-half per cent.

The percentage of superheat, at 92.5 pounds pressure by gauge in the first experiment, was 2.3; in the third experiment, with steam pressure at 91.65 pounds, 8.3 per cent.; in the fourth experiment, with steam pressure at 91.48 pounds, 3.34 per cent.; in the fifth experiment, with steam pressure at 91.44 pounds, 7.09 per cent.; and in the sixth experiment, with steam pressure at 91.54 pounds, 8.06 per cent. The continuous calorimeter was used in these trials.

The former results were from four different boilers of different forms and dimensions, and operated at different steam pressures and rates of evaporation, with a range in the quality of steam from 19 per cent. of superheat to 29 per cent. of primage; whilst the last six re-

sults were all from the same boilers, operated at different times under approximately the same conditions of steam pressure and rate of evaporation, with a range in the quality of steam from 8.3 per cent. of superheat to less than one-half per cent. of primage. From which it appears that, with the same boiler or boilers, operating under similar conditions an approximately uniform quality of steam should obtain, and that the quality of steam in any one instance can not be assumed for another unless the conditions are precisely alike.

The next results to which I shall refer are from three different trials upon the same boilers, operated under similar steam pressures and at different rates of evaporation.

The boilers (two) in the battery were of the return tubular variety, containing 932.02 superficial feet of heating surface.

During the first trial steam was made at the rate of 4.09 pounds per foot of heating surface per hour, with a resultant temperature of 1,153.09 units, indicating a primage at 92.59 pounds by gauge of 7.08 per cent.

During the second trial the boilers were worked at an evaporation equivalent to 2.86 pounds of steam per foot of heating surface per hour, with a resultant temperature of 1,199.04 units, indicating with a steam pressure by guage of 92.95 pounds, a primage of 1.93 per cent.

During the third trial the boilers were worked at a rate of evaporation equivalent to 2.90 pounds of steam per foot of heating surface per hour, with a resultant temperature of 1,174.17 units, indicating at a guage pressure of 92.28 pounds, a primage of 4.75 per cent.

These experiments were made with an intermittent calorimeter.

In all the experiments exhibiting a small percentage of water entrained in the steam or a superheat, the boilers were set to expose more or less of the steam room to contact with the hot gas.

The next results are from a series of three experiments with a small locomotive boiler operated standing.

For the first trial the heating surface was 288.75 superficial feet, and ratio of heating to grate surface 25.9. The boiler was worked at a capacity equivalent to 8.49 pounds of steam per foot of heating surface per hour, with a temperature of steam of 1,150.98 units, indicating at 107.5 pounds pressure by gauge, a primage of 8 per cent.

The apparent evaporation per pound of coal was 4.45, and the actual evaporation was 4.09.

For the second and third trials the heating surface, by the introduction of a water bridge into the fire box, was increased to 300.7 superficial feet, with a ratio of heating to grate surface of 41.67.

During the second trial the boiler was worked at a rate of evaporation equivalent to 9.39 pounds of steam per foot of heating surface per hour, with a temperature of steam of 1,181.76 units, indicating a primage at 98.25 pounds pressure by gauge of 4.33 per cent. The apparent evaporation in this case was 7.58 pounds, and the actual evaporation 7.25 pounds of steam to one of coal.

During the third trial the boiler was worked at a rate of evaporation equivalent to 9.77 pounds of steam per superficial foot of heating surface per hour, with a temperature of steam of 1,259.29 units indicating a superheat at 100.7 pounds pressure by gauge of 88.67 degrees F. The apparent evaporation was 6.41 pounds of steam per pound of coal, and the actual evaporation upon the basis of saturated steam was 6.65 to 1.

The rate of combustion and evaporation was higher for the third trial than for the second, with a better quality of steam and a reduced economy.

In these trials the coal was burned within five or six per cent. of the total weights charged, and the calorimeter results can be fairly compared without correction.

The next result to which I will refer is from the boiler of a "Rogers" engine, on the Ohio & Mississippi Railroad, in a running trial from Vincennes to Seymour, made last July. The heating surface was 984.33 superficial feet, and the rate of evaporation equivalent to 9.51 pounds of steam per foot of heating surface per hour, with a temperature of steam of 1,192.11 units, indicating at a pressure by gauge of 125.56 pounds, a primage of 3.4 per cent. The apparent evaporation in this case was was 3.97 pounds per pound of coal, and the actual evaporation 3.83.

The poor economy of this boiler was largely due to the high rate of coal consumption (146.25 pounds per superficial foot of grate per hour).

With large grate areas, and a reduced rate of combustion per superficial foot of grate per hour, the economy of locomotive boilers may be materially improved, as shown by the results obtained from the

"Wooten" boiler, on the Philadelphia & Reading Railroad. I am aware that some of my professional friends are not seized of of my faith in the reliability of calorimeter results; but I am unable to obtain from them any better objection than that some modifying data has been overlooked or neglected in those cases which do not meet their approbation. But when they agree, as they invariably do, that condensed steam and condensing water may be accurately weighed, and that approximately accurate temperatures may be had with good makes of thermometers, then I can conceive no other objection to accepting the results of calorimeter experiments than the personal errors of observation which pervade all mechanical investigations.

If the power of steam engines is to be measured by the indicator (or the less reliable dynamometer or friction brake); if the economy of boilers and engines is dependent upon the accuracy of weighing scales; if steam pressures are to be taken from spring gauges, and temperatures of feed water read from thermometers, and such results are held to be reliable for absolute effect and for comparison, then the same reliability must, in simple justice, be accredited the calorimeter, for it depends solely upon correct weights and temperatures, and involves no complex or uncertain quantities in the operation.

On motion of Mr. Wilder the paper was received, and the thanks of the Association were tendered Mr. Hill.

Carried.

THE PRESIDENT — The next business strictly in order is the reading of a paper from our other Associate Member, but I would like to have the report which Mr. Forney has prepared, presented at this time and acted upon. If there is no objection we will hear the Report of Mr. Forney upon Axle Boxes.

Mr. Forney then read the following paper:

Report of Committe on Standard Journal Bearing, Journal Box, and Pedestal.

To the American Railway Master Mechanics' Association:

GENTLEMEN—Your Committee, which was appointed last year "to confer with a similar Committee of the Master Car-Builders' Association to consider the subject of a Standard Car Journal Bearing, Journal Box, and Pedestal, and report whether any change is desirable from the standard already recommended by that Associa-

tion," beg leave to report that after conferring with the members of the Car-Builders' Committee it was mutually agreed to issue the following

CIRCULAR:

"SIR—After conferring together, these two Committees have agreed to send out a joint circular to obtain information relating to the subject submitted to them.

"On investigation they find that a Committee of Five, consisting of Messrs. C. A. Smith, I. W. Van Houten, Joseph Jones, David Hoit, and F. D. Adams, was appointed in 1873 by the Master Car-Builders' Association, 'with power to produce a journal box according to their own judgment, that shall be considered the standard box.'

"That Committee had a drawing made of a car-axle journal bearing, journal box, and pedestal. The drawing was lithographed and copies were extensively distributed. On examination of this lithograph it is found that the journal bearing and its key are somewhat imperfectly shown, and if the lithograph was given to different pattern-makers it is extremely doubtful whether the patterns of these parts made from it would be alike. The Committee have also learned, from different sources, that journal bearings and keys which are said to be of the standard form and size are often not alike, and that in some cases the bearings of one road will not enter the boxes of another. They have, therefore, had a new and more complete drawing of the journal bearing and key made from the lithograph referred to and from a duplicate of the original pattern from which the lithograph was made. This drawing has been made with great care, and is believed to be as nearly like what the original standard was intended to be as it is now possible to make a drawing. It has been engraved half size, and a print of the engraving is sent herewith. To enable the Committees to report intelligently on this subject they request that you will give them the following information:

"1. If you use the Master Car-Builders' standard journal bearing and key, will you please compare those you use with the engraving, and if the sizes of yours differ from the dimensions given, please erase them on the engraving, and substitute on it the sizes of the castings which you use, and return the engraving to the Committees. Also state to the Committees any differences in form, if any exist.

"2. Would you recommend any changes in the form or size for

a journal bearing and key from those represented by the engraving or would you prefer a journal bearing without a key? and give yout reasons for such changes as you propose.

"3. If you would recommend a journal bearing and key of different form and dimensions from the standard, please send an accurate full-size drawing of them to the Committees, or, if that is not convenient, send one of the bearings and one of the keys which you would recommend. Before you send them have them distinctly and permanently marked with the name or initials of your road.

"4. In order to enable the Committees to report to what extent the Master Car-Builders' standard axle has been adopted, please state whether it is used on the cars or tenders belonging to your road, and approximately the number now in use.

"As it may be necessary for the Committees to send out another circular concerning the journal box and pedestal before they make their reports, they request that you send replies to the above inquiries as early as practicable."

On conferring together the two Committees have thought that it would be best to make a joint report to be submitted to each of the two Associations. The following is, therefore, their

JOINT REPORT:

To the circular sent out twenty-five replies were received. Of these, five reported that they do not use the standard journal bearing, box, and pedestal. The remaining twenty report either no differences or very slight ones between the pattern of journal bearing, which they use—and the drawing sent—not enough in any case to prevent them from being interchangeable. The Committee do not think, however, that this testimony should he taken as final evidence that differences which would prevent the bearings from being interchangeable do *not* exist. So many reports to that effect have been heard that it is thought that there must be some good ground for them, and that in those cases where Master Mechanics or Master Car Builders have found that their patterns were not right they have thought that it would be more prudent to remain silent than to report the discrepancies.

Of the twenty-five who answered the circular, four say they prefer a bearing without a key. All the others say either that they prefer

a bearing with a key, or recommend that no changes be made in the existing standard.

The answers to the fourth inquiry, referring to the number of axles in use, were so few and meager as to have no value.

After careful investigation, and from the answers received to their circular, the Committees are of the opinion that no alterations in the standard should be made which would prevent new parts from interchanging with the old, or *vice versa*. Some defects in the bearing, box, and pedestal, however, have been pointed out to the Committees which can easily be remedied without interfering with the interchangeability of those parts. The original lithograph which has been accepted as the standard, as stated in the above circular, is a very imperfect mechanical drawing. Some of the parts are imperfectly shown on it, and many of their dimensions are given in minute fractions, such as sixteenths, thirty-seconds and sixty-fourths, when the precision required made this entirely unnecessary. In other cases there were discrepancies which it was impossible to reconcile with each other. The first thing, therefore, which the Committee thought should be done was to make new drawings of the bearing, box, and pedestal, and make these separate from each other, so that their parts could be more clearly represented; and in making the drawings that the minute fractions referred to should be discarded except in such places where they are essential.

The attention of the Committees was called to the fact that the lugs on the sides of the journal bearing, if made of the size shown by the original drawing, are entirely too light, and that whenever they are made of the dimensions represented, much loss and annoyance were entailed by their breaking off. These have therefore been enlarged, but not so as to prevent the new bearing from being used in an old box.

It has been shown, too, that the original depth of the bearing, $1\frac{1}{4}$ inches, measured from its lower edge to the top of the journal, was too great, and that it was difficult to put the bearing in or take it out of the box if made as originally represented. In many cases the patterns have been reduced on this account. In the new drawing this change has been made, and the bearing is represented as 1 inch instead of $1\frac{1}{4}$ inches deep, as it was before.

It is also said that the original key projects so far at the outer end that when the brass bearing is worn away endwise and vertically, the

collar of the axle comes in contact with the key, and thus causes it to cut and the journal to heat. The outer end of the key has therefore been cut away as shown in the drawing.

It has also been pointed out that the back of the box, next the hub of the wheel, is not strong enough. This part has therefore been increased from three-eighths to one half inch thick. It would, perhaps, be desirable to make it still thicker, but there is not room enough between it and the hub of the wheel.

The lugs or flanges on top of the box for holding the equalizing lever in its place have also been reduced in size, and the shape of the outside of the box has been altered and simplified somewhat, so as to give more room for packing the box.

Complaint has been made that there is not wearing surface enough between the box and the pedestal, and that consequently both of them wear very rapidly. For this reason additional flanges have been added to the box, which will come between the inner and outer plates of the pedestal, and will nearly double the lateral and longitudinal wearing surface. These will not prevent the new box from being used with the old pedestal, or *vice versa.*

The shape of the upper part of the pedestal has been modified somewhat, and it is thought improved, so far as appearance is concerned, although the dimensions and position of the bolts have not been changed.

Much fault is found with the original journal-box cover recommended by the first Committee, and some change seems desirable here. The present Committee, however, do not see their way clear to recommending the use of any of the patented covers now in much favor, for the reason that no road would have the right to use them without a license from the patentee. The Committee, therefore, are of the opinion that, for the present, at least, the matter had better be left open for each road to use whatever its officers may think is best.

In order to bring about some definite action with reference to the subject of their report, the Committee recommend the passage of the following resolution:

"*Resolved*, That the drawings of the car-journal bearing, journal box, and pedestal, of which copies are submitted herewith, be declared to represent the standard form and proportion for these parts,

and that the same be recommended by this Association for general use on cars and locomotive tenders."

F. D. ADAMS, JOHN KIRBY, } *Committee of the Master Car-Builders' Association.*

M. N. FORNEY, JAS. SEDGLEY, JAS. M. BOON, W. S. HUDSON, } *Committee of the Master Mechanics' Association.*

It was then voted that the report be received and the appended resolution adopted.

THE PRESIDENT — Gentlemen, I have the applications of three mechanical engineers to become Associate Members of this Association. The first is F. W. Dean, of Cambridge, Mass., recommended by John Black, James M. Boon, and J. H. Flynn; the next is William Kent, of Pittsburgh, Pa., recommended by D. A. Wightman, Chas. T. Ham, and J. C. Haggett; the next is Alexander Gordon, of Hamilton, Ohio, recommended by D. A. Wightman, J. C. Haggett, and J. H. Setchel. These applications will be referred to the proper Committee, who are requested to investigate and report at the earliest possible moment.

The President then stated that the Constitution required certain things to be done at the hour which had arrived. One was to listen to the Report of the Supervisory Committee in connection with the Committee on Subjects, and the President called upon the Secretary to read the Report.

The Secretary stated that in addition to the subjects already announced, the Committee on Subjects would suggest the appointment of committees (1st.), to investigate and recommend a suitable wire gauge for adoption by the Association; (2d.), smoke stacks and spark arresters.

The report was accepted and its recommendation adopted.

The Secretary submitted the Report of the Joint Committee as follows:

Committee on Research: Improvement in Boiler Construction, the Committee of last year, Reuben Wells, Louisville, Ky.; S. J. Hayes, Chicago, Ill.; C. R. Peddle, Terre Haute, Ind.; Jacob Johann, Springfield, Ill.; Jas. Eckford, Cincinnati, Ohio.

Subjects of Investigation:

The Best Material and Form of Construction for Parallel Rods to Prevent their Breaking: Howard Fry, Williamsport, Pa., Chairman.

New Plans of Construction and Improvement of Locomotives: W. Woodcock, Elizabethport, N. J., Chairman.

The Most Practicable and Best System of Paying Premiums to Locomotive Engineers and Firemen to Induce Economy in Working Locomotives: F. M Wilder, Susquehanna, Pa., Chairman.

Standard Wire Gauge: R. H. Briggs, Whistler, Ala., Chairman.

Smoke Stacks and Spark Arresters: James Sedgley, Cleveland, Ohio, Chairman.

The report was received and adopted.

The Secretary then read the following paper on Clearance and Compression, prepared by Mr. C. A. Smith, Associate Member, of St. Louis, Mo.:

Paper of Mr. C. A. Smith on Clearances and Compression in Steam Cylinders.

To the American Railway Master Mechanics' Association:

GENTLEMEN—In presenting to this Association a paper the author is conscious of two things: the first being that he is liable to be classed as a theoretical man by the most practical body of men in the world, and the second being the lack of exact information upon the subject on which he is writing.

The subjects of Clearance and Compression are very closely connected, and it is only for the sake of clearness that we will look at one without the other in briefly reviewing the ground.

First suppose a cylinder in which the exhaust closes at the end of the stroke in which we have no compression; at the time of opening the exhaust valve the clearance is full of steam at the cylinder pressure near the end of the stroke; for convenience imagine the exhaust to open at the end of the stroke, and then whatever steam may have been in the clearance goes out with the exhaust and all the steam is swept out of the cylinder except the small portion at the atmospheric pressure, or nearly so, which remains in the clearance space when the exhaust valve closes. Clearly in this case there is a dead loss by clearance, which is very nearly the whole clearance space full of steam at the terminal pressure.

To illustrate: the clearance of an ordinary 16 by 24 inch engine is about eight per cent. with 135 pounds of steam, the loss when working full stroke would be about seven per cent. The fact is that the exhaust opens before the end of the stroke, and in full gear forwards the proportion which the clearance space bears to the volume of steam in the cylinder is increased, the loss being about eight per cent.

If in working expansively the exhaust did not alter with the distribution of steam we should find the loss the same whatever pressure existed at the end of the stroke; but with the slide valve and link motion the exhaust occurs earlier in the stroke, and so also does the closure. Neglecting the latter for the time being we find the exhaust opening at say at seventy per cent. of the stroke, and the loss is then increased to ten per cent. from eight per cent.; but as the

exhaust valve closes at say sixty per cent. of the stroke, leaving a volume of forty-eight per cent. to be compressed to eight per cent., or six times, thus partially filling up the clearance space with steam which does not have to be supplied by the boiler, and so reducing the loss, but also increasing the back pressure work, which is an evil instead of a blessing.

On the supposition that steam is a gas, many writers have made mathematical investigations as to where in a given cylinder the valve should close the exhaust to get the most work from a given quantity of steam, or the least steam for a given work; but as steam is very far from being a gas the writer considers such investigations as being of little value and of no use in view of the following facts:

When steam of high pressure comes from the boiler it is also at a high temperature, and the first thing it meets is iron surfaces which has just been exposed to the exhaust steam more than one hundred degrees lower and which have become cooled. The first thing done is for that steam to condense and warm up the iron, and its place is supplied by fresh steam. When the pressure falls, after cut-off the iron remains hotter than the steam, and at once commences to warm up the steam, but this returning heat to the steam continues throughout the exhaust, and thus some of the heat gets switched round the cylinder on an iron side track without doing the work it ought to do on the piston. This is shown experimentally by the cylinder pyrometer of Mr. Dixwell (described in my paper of last year, and has been known for many years). Not only does the iron act in this way, but so also does the water in the steam; in fact the water present is the means of communication between the steam and iron, and if there be no water present the means of communicating heat is gone and much less heat is lost in this manner.

The surfaces which do most of the business are the surfaces of the piston, cylinder heads, and ports, in fact the very surfaces enclosing the clearance volume; and if the compression has been strong enough to reach full boiler pressure when the steam valve opens, the steam from the boiler can not be condensed by these portions of the metal, and part of this evil will be avoided by having dryer steam at the cut-off. With the ordinary proportions such compression is attended with too much back pressure work to be economical, and, in fact, is never reached except with the link in midgear; but with a reduction of clearance, not in the cylinder itself, but in the space

beyond the cylinder, in the ports, such a degree of compression is readily obtained in the lower notches without increase of back pressure work, and only exceeding the boiler pressure when the engine is run on the center or first notch from the center.

Thus we see that, looked at from every side, the clearance space beyond what is necessary in the cylinder for mechanical reasons is a nuisance, and that a reduction of such useless space can be in no way detrimental when the engine has full work to do, and that with all but the lightest work the back pressure will not exceed the boiler pressure (and for such cases less lead will be a remedy), and if it does there can no harm result. But as economy of steam is more important on the forward gears than in midgears, we may safely conclude that any reduction in clearance will be certainly followed by economy of steam when it is most needed, and the economy so reached will be at least that due the change of volume, while, because of drying steam in the cylinder, it may very considerably exceed this amount.

The only information on this point which I have with locomotive engines is from the valuable paper by Mr. John E. Martin, published in the Association Report of 1878, where Mr. Martin changed the clearance of a 15 by 24 inch engine from eight to six per cent.; but in the trials so made the engine appears to have been worked in the first notch only, and Mr. Martin reports a loss of from three to five per cent. by this change. Mr. Martin states that the computed consumption of steam was borne out by measurement of the water used, but gives no particulars. I regard the computations of the steam used from the indicator diagrams as the only unfortunate point in Mr. Martin's paper. Such computation is based on the assumed use of dry saturated steam, a condition never realized in the cylinder. Even if this deduction of Mr. Martin's is correct for the case as he tried it, there can be found no extension of his conclusions to the engine working with less expansion than he used; *i. e.* cut-off at 4½ inches. (With a cut-off at 6½ inches, and the engine No. 180 tested by Mr. Johann and myself in 1877—see Report of 1878 of this Association—the cushion pressure would not have reached the boiler pressure if the clearance had been five per cent. in place of eight per cent. when running on the first notch.)

In support of the views advanced I can only instance experiments with stationary cylinders which tend to confirm the conclusions offered

as far as increase of cushion pressure is concerned; but I can see no reason, apart from external cooling, that steam acts any differently in locomotives from what it does on other cylinders. Two trials were made upon the same bed plate with same crank, with cylinders and valve gear by two makers; in both cases was the valve action regulated by the governor. The size of the cylinders was the same, and the work done was the same.

For the particulars I am indebted to a report by Mr. John W. Hill:

	A	B
Diameter cylinder	22 inches.	22 inches.
Stroke	36⅛ "	36⅛ "
Revolutions	88	91
Clearance	12 per cent.	4 per cent.
Compression	10 " "	13 " "
Real expansion	4	5
Steam pressure at cut-off	83 pounds.	78 pounds.
At end stroke	8 "	3 "
At closure	3 "	1 "
Mean effective	31 "	30 "
Cushion	17 "	45 "

Computed economy of B over A, by writer ....25 per cent.
Result of trial .... 39 " "

There may be many reasons for this wide difference in the practical character of the engines, but the cushion pressure is most notable.

A second case, in which every confidence may be placed, is a trial made by M. Hallaner, and given by him in the Bulletin de la Societe de Mulhause for April, May, June, 1879, upon a large compound engine, in which an economy of two per cent. was made when working at 180 horse power, and of nine per cent. when working at 346 horse power, by changing the closure from ten per cent. to twenty-five per cent. in the small cylinder only.

It seems as if scarcely any improvement was possible in the modern locomotive, and all claims of large savings are utterly absurd as of heating feed, and giving oxygen to the fuel by some chemical process; but if the clearance space can, by the use of a long cylinder with deep counter-bores and sunk heads, with the port openings in the valve seat over those in the cylinder, and with two exhaust ports, and value in two portions (if not in two pieces), be reduced from eight to five per cent., we have the certainty of an economy of

three per cent., which may be exceeded for all cases where the engine has hard work to do.

The paper was accepted.

On motion of Mr. Briggs, a paper submitted by Mr. Forney was referred to the Advisory Committee, they to have power to incorporate it in the Report of the Annual Meeting if they see proper. A vote of thanks was also tendered Mr. Forney for presenting his paper.

Paper of Mr. M. N. Forney on Attachments to Locomotive Boilers.

To the American Railway Master Mechanics' Association :

GENTLEMEN—During the last year or two my attention has been attracted to that class of accidents which occur on railroads in which a great part of the injury to persons is due to the escape of steam from locomotive boilers. This is due nearly always to the knocking off of some of the numerous attachments which must be used in connection with such boilers, as it rarely happens that the boiler itself is perforated in any way when a collision occurs. To show the terrible effects of such accidents, the following account is given of some which have occurred during last year, which have been collected from the reports of Train Accidents in the Railroad Gazette and from other sources:

"On August 5 a freight train on the New London & Northern Railroad ran into the rear end of a passenger train, which had stopped at Thames Grove, Connecticut. The rear car was broken in and the boiler of the freight engine was damaged so that steam escaped into the wrecked car, scalding a number of people. Ten persons were hurt, three of them seriously."

"On August 18 a freight train on the Pittsburgh, Cincinnati & St. Louis Railroad was broken in two near Crown Point, Indiana, and the detached cars ran back down grade and into the head of a following freight. The caboose was forced up on the second engine, breaking the steam pipes so that steam rushed out, scalding the conductor, brakeman and four drovers, who were in the caboose, so that three of them died soon after. The engineer was also hurt."

"On August 11 the second section of a crowded excursion train on the West Jersey & Atlantic Railroad ran into the rear of the first section which was slowly pulling into a siding at May's Landing, New Jersey, where an express train was to be met. The engine of

the second section went completely through the rear car of the first, wrecking it badly, scattering the passengers in every direction. The cylinder heads were broken and the car was filled with steam, scalding many of the unfortunate passengers. The number reported killed at once or since dead from injuries is 28, and 47 others were more or less hurt."

From other sources of information it has been learned that the escape of steam in this case was due to the breaking of the T pipe in the smoke box to which the steam pipes were attached.

"On October 9, near midnight, an extra passenger train on the Pennsylvania Railroad ran into the rear of a preceding passenger train which had been stopped by a block signal at Twenty-eighth street, in Pittsburgh. Both trains were crowded with people. The engine of the second train cut its way into the rear passenger car, throwing the people in every direction. There were 32 persons killed or hurt so that they have since died, and 17 were less severely hurt."

The writer had an opportunity of examining the engine which ran into the preceding train soon after the accident. A great part of the fatality was due to the breaking or knocking off of one of the check-valve cases, which allowed the steam to escape into the car. Had this not occurred comparatively few persons would have been killed.

"On October 20 a passenger train on the Cincinnati, Hamilton & Dayton Railroad ran into the rear of a preceding passenger train, which was just going into a siding at Jones Station, Ohio. The second train crushed into the rear car of the first, breaking it up badly, and the steam escaped into the car, scalding the passengers who were unable to get out. Fifteen persons were hurt, of whom three afterward died."

In this case, too, the writer had an opportunity to examine the engine soon after the accident, of which he then wrote the following account:

"An officer of the road stated that the engine ran under the floor of the car so that the latter was on top of the boiler. The dome, which was over the fire box, however, crushed in the end of the car so that the latter was about over the foot board. In doing so the injector valve—a common globe valve back of the dome—was broken

off, and from this the steam escaped into the car. Most of the passengers were thrown to the front end, and as the steam escaped into the back end the injury from scalding was not nearly so great as at Pittsburgh. In the latter accident it was hot water that escaped from an opening about 2¼ inches diameter; whereas, on the Cincinnati, Hamilton & Dayton engine it was steam which escaped and not water, and the opening was only about 1¼ inches diameter. The neck of one of the check-valve cases, to which the feed pipe was attached, was broken off, but the check valve was left intact. The flange of the case, by which it was bolted to the boiler, was, however, loosened, and, doubtless leaked; but as this was below the floor of the car after the accident happened, probably it did but little damage."

On February 22, of this year, the regular train was just leaving President, a station on the River Division of the Buffalo, Pittsburgh & Western Railroad, near Oil City, when a special, running at the rate of 40 miles an hour, plunged into it from behind. The rear passenger coach on the regular train was badly wrecked, and aside from bodily injuries, many of the passengers were badly scalded by the escaping steam from the locomotive, which almost immediately filled the coach. Five passengers were badly, one it was supposed fatally, and nine slightly hurt.

No attempt will be made to describe the human suffering which resulted from these six accidents, which have occurred in less than a year and a half, and in which 79 persons were killed and 83 injured. The sufferings of many of those who were not instantly killed must have been of the most excruciating character. No torture could produce more agony than some of the victims must have suffered. It is not with any intention of giving a dramatic interest to this paper that the following accounts which have appeared in the daily press are also recounted; but to make those in charge of the construction and operation of locomotives realize as vividly as possible the suffering which is often caused by accidents of the kind described, part of which it is in their power to prevent.

An accident happened on the Second Avenue Elevated Road on October 11, of last year, in which a train ran into one in front, and the account says:

"The fireman was slightly scalded; the engineer was badly scalded

and thrown 30 feet down into the street below, being hurt so badly that he died in an hour."

On November 16, as a train was approaching Wilkesbarre, Pennsylvania, and had just crossed a bridge, the locomotive jumped the track and dragged a passenger car with it down a steep embankment. The daily papers reported that: "McMahon, a flagman, who was signaling for a coal train, and had stepped aside to let the train pass, was struck by the engine, and had his head severed from his body. John Sweeny, the fireman, was caught in the wreck and was fatally scalded. Henry Murphy, a brakeman, was struck by the engine and had his collar bone broken, and he, too, was horribly scalded. Patrick Manaman, another brakeman, was injured internally and badly scalded. The shriek of the injured lying under the engine, which was emitting dense clouds of steam, was appalling. Women fainted, and strong men shook nervously as they stood unable to help the poor sufferers."

In this case the immediate cause of the escape of steam was that the engine struck a tree, which raked every thing but the dome from the top of the boiler.

On November 27 an express train on the Pittsburgh Division of the Baltimore & Ohio Railroad, while rounding the precipitous curve, known as Baughman's Bend and Smoky Hollow, about thirty miles west of Cumberland, was thrown down an embankment from 80 to 90 feet high. The report in the papers said: "The fireman, Jacob Rowth, was caught under the engine, and after suffering indescribable torture from scalding, for the space of three hours, in which his cries and groans were heartrending, finally died; the passengers, although willing, being unable to relieve him from his terrible fate. The engineer, Peter Briney, was badly, and it is feared, fatally scalded by the escaping steam."

On May 21, of this year, the Chicago bound train in what is called the "Kankakee Line" of the Cincinnati, Indianapolis, St. Louis & Chicago Railroad, when near Templeton, Indiana, was thrown from the track by a drove of cattle. The papers said of this accident: "The engineer reversed the lever and saved his life by jumping, but the fireman was caught under the water tank of the engine and pinned to the ground. His screams for help, as he was slowly roasting to death, were agonizing. It was over two hours be-

fore the poor fellow could be extricated from his horrible position. His vitals and limbs were all roasted and scalded.

On May 24 a wild-cat engine ran into locomotive drawing a passenger and freight train on the Chatham & Hudson Branch of the Boston & Albany Railroad, at Ghent, New York. The Chatham Courier, in its report of this accident, said: "Robert Best, engineer of the passenger train, and Charles H. Deweese, the fireman, were instantly killed. The cab of their engine was reduced to matchwood by the tender. The sides of the tender mounted on the boiler and closed round the unfortunate men, who were turned by the shock with their backs to the head of the boiler, against which they were tightly jammed by the debris of the tender and the contents of the first coal car. Deweese stood with arms and face uplifted to the sky. Beside him, but lower down in the hole, was the body of Best. Only his head and breast were visible. His back was broken and crushed. His uplifted left arm was broken in several places. The lower portion of his body was horribly mutilated, and one of the gauge cocks was driven into his side."

It was said by some of those who first saw the body of Best that steam from the gauge-cock, which entered his side, was escaping from his mouth. The horror of this is mitigated only by the fact that both men, it is reported, were instantly killed.

The experience of Master Mechanics could, no doubt, largely increase the ghastly and terrible list of such accidents, and the sickening details which attend them. But it was not my purpose in writing this paper to make it only a recital of appalling accidents and of the pain and torture which attend them, but to lead you to consider some means of preventing or diminishing some of the sufferings produced by such disasters.

Your experience will probably agree with my observation, that it is comparatively rare that the plates of a locomotive boiler are perforated in a collision. The escape of steam is nearly always due to the breaking or knocking off of some of the attachments to the boiler, which thus leaves an opening from which the steam or hot water escapes. Perhaps few of you will realize how many such attachments there are on an ordinary locomotive until you see them enumerated.

The following list includes all that are generally used:

1 T pipe	1	opening.
2 Check valves	2	"
2 Safety valves	2	"
1 Whistle	1	"
1 Throttle-valve stem	1	"
2 Injector valves	2	"
2 Blow-off cocks	2	"
4 Gauge cocks	4	"
1 Glass-water gauge	2	"
1 Blower valve	1	"
1 Throttle for air pump	1	"
1 Steam-gauge cock	1	"
2 Cylinder oiling cocks	2	"
1 Surface cock	1	"
Total	23	openings.

Any of these is liable to be broken off in case of a collision. Besides these there are a number of hand holes and a dozen or two of studs which are screwed into the boiler for various purposes. In case of accident the studs generally break outside of the boiler, and thus leave the holes plugged up. The hand-hole plugs or covers are not much exposed, and are not liable to be injured so as to allow steam to escape; but as every locomotive runner knows, any one of the other parts is liable to be broken when an accident happens to the locomotive.

The problem which presents itself to Master Mechanics, and those who design locomotives, is how to make these parts more secure and less liable to injury by collision, or when an engine runs off the track. To do this in the most perfect manner will, of course, require the exercise of a great deal of ingenuity and constructive skill. There are, though, some means which suggest themselves which would materially lessen the risk of injury to some of these parts, or which would supply a safeguard to prevent the escape of steam if they were injured.

In the case of the accident at May's Landing, the engine had, we think, although not quite certain of it, an old.fashioned throttle valve in the T pipe. Of course, when the latter was broken, the steam escaped, no matter whether the throttle was closed or not. Generally a locomotive runner will close the throttle before an accident occurs, especially in case of a collision, when he sees the train

in front of him. If the throttle valve is in the dome, the plan now generally adopted, the steam would not escape, even if the **T** pipe was broken, unless at the same time the dry pipe on the inside of the boiler was displaced. The inference from this is, or should be, that the old plan should be abandoned, and the throttle valve should be placed in the dome. If steam is not shut off in case of a collision, it is hard to see how to guard against what happened at May's Landing; nevertheless it is a problem on which inventive skill may, perhaps, be profitably exercised.

The position in which check valves for injectors are now placed is a case of the survival of a habit when the reason for it has passed away. When pumps were the only means of feeding boilers, and they were worked from the cross-head, the check valves were quite naturally placed as near to them as they could be, and at the same time deliver the water near the front ends of the tubes, which is generally considered desirable. When injectors are used, however, the conditions are quite different. They should be as near to the locomotive runner as possible, and therefore, if the water is delivered into the boiler through the check valve, in its old position, the two must be connected by a long pipe which is liable to injury and is exposed to cold, so that the water in it is apt to be frozen when the injector is not working. It has therefore been proposed that instead of placing the check valve in the old position near the front end of the boiler they should be attached to the back end of the fire box, in immediate proximity to the injectors, and that the water should be conducted to the front end by a pipe on the inside of the boiler. To do this the form of injectors would require to be changed so as to stand vertically instead of horizontally. Doubtless the manufacturers of these instruments would soon do this if the change was demanded. Such an arrangement would eliminate altogether the danger of injury from the immediate cause which produced such terrible results in the Pittsburgh accident. It may be said, however, that while the danger of this kind of accident would be removed, the check valves, if attached to the back end of the boiler, would still be exposed to injury in a collision or derailment, and especially, as often happens, if the tender mounted up over the foot board, thus exposing the locomotive runner and fireman to greater risk. This suggests the problem of making a check valve which would not be exposed to such danger. In the ordinary form

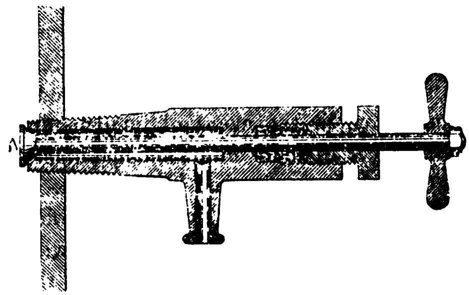
of construction the valve is held in a case which is attached to the boiler by a more or less slender neck. A severe blow or concussion breaks the case off at the neck and carries the valve with it. It would not seem an impossible nor even a very difficult task to make a check valve and case which would be so arranged as to be on the inside of the boiler, and yet so attached that it could be easily removed from the outside when the valve required cleaning or grinding. The injector pipe would then be attached by a neck of the valve case, and thus in the event of its being broken off the valve would be left intact. The inventors and manufacturers of injectors have shown so much ingenuity and skill in perfecting these instruments that they would probably have little difficulty in working out a plan which would fulfill the conditions which have been described. It would probably be very much to their advantage to do so, and in the event of its being a source of profit to them a liberal commission will be expected by the author of this paper.

The check valves are, however, only *one* source of the danger pointed out. There still remains about twenty cocks of various kinds which usually are each attached separately to the boiler, any one of which if broken off would allow enough steam to escape to scald a whole car full of people. What shall be done with these? In some cases a half-dozen or more of them are attached to a stand which is connected with the boiler by a single opening. This diminishes the danger by concentrating these parts in a smaller space, and thus lessening their liability of injury. But it is evident that if any one of the cocks attached to a stand of this kind is knocked off, it would allow steam to escape the same as though it was attached directly to the boiler. This plan therefore lessens only to a slight degree the danger from this source, although there are other advantages in using such stands. There are besides other parts, such as safety valves, whistles, gauge cocks, etc., which can not be attached to a stand of this kind. What shall be done with them to make them safer?

In the Railroad Gazette of November 5, of last year, some discussion and suggestions on the subject of this paper were published. In response thereto a correspondent, Mr. S. D. Webster, of St. Louis, wrote to the editor as follows :

" Let me suggest that a combination of the ordinary valve mechanism with the so-called Mississippi River gauge-cock valve, represented

in the engraving herewith, may be advantageous if the number of perforations can not be reduced. For the information of those who may not know what the last named is, I will say that it is simply a button, *A*, in the end of a stem. It is pressed outward against the



tube of brass, in which it is contained, by the steam. To try his gauge the engineer pushes the stem with a rod; when he withdraws the rod the valve closes. The reverse is the case with a locomotive gauge cock. The turning of a screw withdraws the valve. My suggestion, therefore, amounts to this—let the valve (button) be larger than the orifice, and on the inside of the boiler, and *let the turning of the screw push it into the boiler*, the steam or water escaping around the stem. This will have the effect of leaving the perforations closed in more than half the cases you enumerate, because the stem would break off if the part outside the boiler did so, but the valve proper—the button—would still be held in place by pressure of steam."

This suggestion, it is thought, contains the germ or the key to the solution of the difficulty. Not only the gauge cocks but nearly all the other cocks and valves which are used in locomotives open outward. If these were arranged so as to open inward they would provide a safeguard against the escape of steam if the outside projection is broken off. There are some difficulties in the way of using such a system, because, as every practical man knows, all the valves about locomotives frequently need refitting, and are liable to be clogged by foreign substances in the water. They must therefore be so arranged as to be easily removed and so that their seats will be accessible. This does not seem, however, to be an insurmountable difficulty, and what is needed is that the whole system of cocks

and valves, which are attached to locomotive boilers, should be designed so as to open inward.

Some special difficulties may be encountered as in the case of safety valves, which must open outward; but a check might be designed to be attached to them which would be open when the valve was closed, but which would close after the valve had lifted more than the normal distance.

The design of some such system of boiler fittings is an inviting field for inventors, and a promising one to the manufacturers of such appliances. To them it is for the present left. If this paper will have the effect of directing their and your attention to this subject, and thus diminish the terrible suffering now so often inflicted and endured, the awful agony of which none but the victims can ever faintly even realize, and the very horror of which leads persons to avoid thinking of it, the purpose of the writer will be accomplished.

The President then stated that the Committee to whom was referred the applications of the gentlemen proposed for Associate Membership, reported favorably for each, whereupon the Association proceeded to ballot, and they were each successively and unanimously elected Associate Members of the Association.

Mr. J. H. Raymond, of Chicago, Illinois, called attention to the report which the Committee on Amendments to the Constitution (of which he was Chairman) submitted last year, and said the amendment to Section 6, Article V, providing for the printing of the papers to be submitted, and supplying the members with them at the commencement of each Annual Convention, had not been carried out. He thought it was impossible tó undertand adequately many of the papers submitted upon hearing them read, and thought the amendment referred to should be put in force.

The Secretary thought it to be impracticable to do so on account of the expense, the uncertainty that the paper would be acceptable to the Association, and because it would be unwise to print ańd circulate the papers before the Association had received them. Further, he had been instructed by the Supervisory Committee not to carry out the requirement of the Constitution in that respect.

Mr. Hayes thought the expense of printing the papers beforehand would not be great, as the type could remain set up for printing in our Annual Report. He thought papers could be thus circulated among members without being broadcast to the public.

The President thought dilatoriness on the part of Committees was a hindrance to printing the papers beforehand. The Committees should see to it that the Secretary is in possession of all the papers in season to have them printed and distributed at the beginning of the Annual Meeting.

Mr. Wilder thought that by having the papers beforehand the members would be able to discuss them in the Convention much more intelligently than they can by simply hearing them read.

On motion of Mr. Raymond it was voted that the attention of the Supervisory Committee be called to the last clause but one of Section 6 of Article V of the Constitution, and that they be instructed to carry out its provisions next year to the fullest extent possible.

The President then read an invitation to visit the Corliss Steam Engine Works and witness the working of the large pumps in use there; also an invitation for members to visit the Hancock Inspirator Works, in Boston, and inspect the machinery in operation there.

THE PRESIDENT—The next business in order is the election of officers.

Mr. WILDER, New York, Lake Erie & Western Railroad—I have a resolution which I wish to offer: WHEREAS, the practice of postponing the election of officers from one year to another is pernicious, therefore,

Resolved, That it is the sense of this Convention that no such motion should be entertained at any Convention, but that an actual ballot for officers should be had at each Annual Convention as provided by the Constitution.

I would therefore move that we now proceed to ballot for officers for the ensuing year.

Mr. SETCHEL, Little Miami Railroad—I am always in favor of taking a ballot and opposed to postponement, but the postponement is according to the Constitution if it is deemed expedient; but I think if Mr. Wilder will make a simple motion to proceed to elect officers he will accomplish the desired purpose. This resolution proposes to amend the Constitution.

THE PRESIDENT—I do not understand it quite as Mr. Setchel does. This simply calls attention to the fact that we have sometimes postponed the election of officers, which is, I think, a bad thing to do, and I hope the resolution will be adopted.

Mr. WILDER, New York, Lake Erie & Western Railroad—In offering that resolution I hope all the present officers will be re-elected. I, for my own part, shall vote for them; but, I think, the manner of doing the business heretofore has been, as the resolution states, "pernicious," and the Association has been harmed by it. That is the reason I offer it.

The resolution was then adopted.

Mr. Briggs, one of the previously appointed tellers, being absent, Mr. G. E. Boyden, of the New York and New England Railroad, was appointed in his place.

Mr. Wilder nominated Mr. J. N. Lauder for President, and upon the ballot being taken it was declared that he had been unanimously elected.

THE PRESIDENT—Gentlemen, I thank you for the honor you have done me in re-electing me to the office of the President of this Association; as such I shall endeavor in the coming year to perform the duties pertaining to that office to the best of my ability. If I have made any errors of omission or commission in the past year I hope you will excuse them. If there

have been such, they have certainly been errors in judgment and not in intent.

The next business in order is the election of Vice-Presidents.

The balloting was then proceeded with, and resulted in the election of the following as the Officers of the Association:

President—J. N. LAUDER, Concord, New Hampshire;

First Vice-President—REUBEN WELLS, Louisville, Kentucky;

Second Vice-President—JAMES SEDGLEY, Cleveland, Ohio;

Secretary—J. H. SETCHEL, Cincinnati, Ohio;

Treasurer—S. J. HAYES, Chicago, Illinois.

THE PRESIDENT—We have completed the election of officers with the excion of appointing a member of our Standing Committee.

A ballot was then taken, and Mr. J. H. FLYNN was elected for three years.

THE PRESIDENT—I desire to say at this time, and I think, under the circumstances, it will be eminently proper for me to say that I hold some views in regard to the tenure of office, as it relates to the position of President, that I wish to place before the Association for their consideration. The position of President of this Association is eminently an honorary one; the duties are not excessively onerous, and I think it is not quite fair to other members of the Association for any one man to monopolize that position for any great length of time. The Secretary and Treasurer are different; they have duties that are very hard at times, and great responsibilities are connected with their office; duties that many of us, perhaps, are not capable of performing in a proper manner, and I venture to say three-quarters of us would hardly wish to accept on this account; but in the case of the office of President the circumstances are reversed. It is eminently an office of honor in the Association, and therefore I think there should be an unwritten law in regard to this matter, that no man shall hold the office of President of this Association continuously over two years. You have just elected me to the office for the second time, and I wish to say here that, in order to carry out my views in this matter which I believe to be correct, one year from this time I shall not be a candidate, because I think we should have rotation in office in connection with the office of President. You can readily see that if one man monopolizes that office it will be wrong in several ways. In the first place we may get into grooves. We want to avoid that. We must progress, or we shall soon cease to be efficient. Then, again, it is an office of honor. There is hardly a member of this Association, I will venture to say, but would make a good presiding officer, and the members should have the chance to occupy that position without having to wait a life-time for it.

Mr. RAYMOND, Chicago, Illinois—Mr. President, I desire to offer the following motion:

Resolved, That Section 3 of Article II of the Constitution of this Association be and the same is hereby repealed; and that Section 2 of Article II

be and the same is hereby amended by substituting for the words, "a regular meeting," the words, "each Annual Convention."

The motion was adopted.

On motion of Mr. Woodcock it was voted that the compensation of the Secretary be the same as last year, $600.

The Committee on Place of Holding the next Annual Meeting reported three places: Niagara Falls; Pittsburgh, Pennsylvania; and Louisville, Kentucky.

Mr. Forney objected to Pittsburgh on account of the lack of suitable hotel privileges, and hoped the Association would never meet there until a hotel was provided in which gentlemen could be properly accommodated.

Mr. Raymond moved that when the Convention adjourned it adjourns to meet at Niagara Falls next year.

Mr. Raymond's motion was then adopted.

THE PRESIDENT—I suppose the time of holding our next Annual Meeting would now properly come up for consideration.

MR. WILDER, New York, Lake Erie & Western—I think the time we have appointed by our Constitution for holding the Annual Meeting is rather unfortunate. I know how business pressed with myself, and I presume it was the same with other Master Mechanics. During the past winter we have had about all we could attend to from November until the middle of April to keep our roads running, saying nothing about preparing ourselves for the discussion of subjects that are to be brought before this Association; and if the time could be postponed, so that after our hard work of the winter is over, we can have time for thinking over these matters. I think it would be a good deal better, and in order to bring this matter before the Association I would move that our next Annual Meeting of this Association be held at Niagara Falls in the last week of August next year.

The month of August as the time for holding the meeting was objected to by several gentlemen, as many members could not then attend, and because the hotels would be full.

Mr. Wilder then stated that he would withdraw his motion, and moved that Section 1 of Article V of the Constitution be amended so as to read that "the regular meeting of the Association shall be held annually upon the third Tuesday in June."

The motion was seconded and adopted.

Mr. Setchel suggested the advisability of having the Annual Meeting of the Master Mechanics' Association and the Annual Meeting of the Master Car Builders' Association held at the same place on the same days, one body to meet in the forenoon and the other in the afternoon.

Remarks were made by Mr. Raymond and the President in regard to certain difficulties in the way of carrying out this suggestion.

Mr. Raymond finally offered a motion that this Association appoint a committee of three to confer with a similar committee which the Master Car Builders' Association should be asked to appoint, said committee to report

next year upon the advisability of thus holding the respective meetings at the same place on the same days. The motion was adopted.

M. SETCHEL, Little Miami Railroad—I have a communication here from the Railway Review, of Chicago, and the Railroad Gazette, of New York, jointly, which I desire to present.

To the American Railway Master Mechanics' Association:

GENTLEMEN—As the question of printing reports prior to the meeting of the Annual Convention has been under consideration we make the following proposition:

We will put reports sent to us up to within ten days before the meeting in type, and furnish one hundred printed copies of the same at the opening session. Such papers will not be published until after the Convention meets, and not to make them public in any other manner. We will also make suitable engravings from drawings furnished in connection with the papers, and which are necessary to a thorough understanding of the reports, provided the drawings are placed in our hands suffieient time, which should usually be three weeks before the meeting. In cases of emergency, papers furnished one week before the meeting will be put in type and printed copies furnished. The whole number of reports should be divided as nearly equal as possible between the two journals. After the reports and papers are published by us, we will give the engravings to the Secretary of your Association for use in your Annual Reports; the Association not to be at any expense for such printing or engraving.

Respectfully,

WILLARD A. SMITH, *Railway Review.*
M. N. FORNEY, *Railroad Gazette.*

Mr. WILDER, New York, Lake Erie & Western—I move that the very liberal offer of the gentlemen representing the Review and Gazette be received, and that the thanks of this Association tendered them therefor, and that their proposition be accepted, and the Secretary and Supervisory Committee be requested to furnish them the reports in proper time for them to carry out their proposition.

The motion was seconded and adopted.

The President then announced as the Committee last voted for, the following gentlemen, stating that the reason he did not appoint Mr. Raymond, the mover of the motion, on the Committe was because Mr. Raymond requested him not to do so: F. M. Wilder, James Sedgley, and William Woodcock.

THE PRESIDENT—I will appoint the following committees to prepare resolutions: On the death of JOHN SWIFT, J. C. Ellis, James Sedgley, and F. M. Wilder. I appoint those gentlemen because I think they were as well ac-

quainted with the deceased as any of our members, Mr. Ellis having been connected with the same works. On the death of B. F. GREGG I would appoint J. H. Setchel, James Eckford, and J. S. Patterson.

Mr. Briggs then read the report of the Committee on Resolutions, as follows:

To the American Railway Master Mechanics' Association:

GENTLEMEN—Your Committee feeling that the meeting of the American Railway Master Mechanics' Association, at Providence, at their Fourteenth Anniversary, has been a source of profit to its members, and will long be remembered with great pleasure by them, desire here to mention some of the circumstances and conditions that have contributed so much to our comfort and enjoyment.

The hall selected for our meetings has proved to be remarkably well suited to meet our wants on this occasion, not only on account of its convenient location and comfort, but particularly on account of its quiet and freedom from any noise from the street or any other quarter; our cordial welcome by the Mayor of the city, and the appropriate prayer by the Rev. Mr. Woodbury, who favored us with his presence at our opening, was fully appreciated.

We find ourselves most hospitably and satisfactorily entertained by the gentlemanly proprietors of the Narragansett Hotel; their efforts to make us comfortable will long be remembered as a pleasant feature in our visit here. We have enjoyed very much the sail down the river, and the "clam-bake" provided, without which our visit here would lack one of the peculiar fascinations that ever hang around this very interesting though small member of our glorious Union. We all remember that Providence, very early in its history, took a very high stand in her mechanical products which she has ever since sustained. We shall long remember the pleasure experienced in our visit to two of the many factories that have long since been known and their products fully appreciated by us as railroad mechanics—we refer to the Rhode Island Locomotive Works and to the Nicholson File Company. We have been well and fairly reported by the press. Therefore, be it

Resolved, That our cordial and hearty thanks are due, and are hereby tendered to each and all these parties.

J. W. PHILBRICK,
R. H. BRIGGS,
J. F. DEVINE,
W. WOODCOCK,
Committee.

The resolutions were adopted.

THE PRESIDENT—I would say, for the information of the Association, that the Committees appointed to draft suitable resolutions in regard to the death of our members are not expected to report at this meeting. Their Reports will be made and sent to the Secretary and incorporated in our Annual Proceedings. We will now hear the Report of the Committee on Finance.

Mr. GEO. RICHARDS, Boston & Providence Railroad—As Chairman of that Committee, I have to report that we have received $305, which I now hand to the Secretary.

THE PRESIDENT—I would congratulate the members on the fact that we have collected $305 this year. Last year, I think, we collected less than $250. This shows a very marked improvement in the numbers present, as well as in the financial condition of the Association.

On motion of Mr. Raymond the Convention then adjourned *sine die.*

CONSTITUTION,

As Amended at the Sixth Annual Meeting, Baltimore, May 13, 1873.

PREAMBLE.

We, the undersigned Railway Master Mechanics, believe that the interests of the Companies by whom we are employed, may be advanced by the organization of an association which shall enable us to exchange information upon the many important questions connected with our business. To this end do we establish the following

CONSTITUTION.

ARTICLE I.

SECTION 1. The name and style of this Association shall be the AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION.

ARTICLE II.

SEC. 1. The officers of the Association shall be a President, a First and Second Vice-President, a Secretary, and a Treasurer.

SEC. 2. The above-named officers shall be elected separately, by ballot, at each Annual Convention, and a majority of all votes cast shall be necessary to a choice.

SEC. 3. Two tellers shall be appointed by the President to conduct the election and report the result.

ARTICLE III.

SEC. 1. It shall be the duy of the President to preside in the usual manner at all the meetings of the Association, and approve all bills against the Association for payment by the Treasurer.

SEC. 2. It shall be the duty of the Vice-Presidents, according to rank, to perform the duties of the President in his absence from the meetings of the Association.

SEC. 3. In case of the absence of both President and Vice-Presidents, the members present shall elect a President *pro tempore.*

SEC. 4. It shall be the duty of the Secretary to keep a full and correct record of all transactions at the meetings of the Association; to keep a record

of the names and places of residence of all members of the Association, and the name of the road they each represent; to receive and keep an account of all money paid to the Association, and at the close of each meeting deliver the same to the Treasurer, taking his receipt for the amount; to receive from the Treasurer all paid bills, giving him a receipted statement of the same.

SEC. 5. It shall be the duty of the Treasurer to receive all money from the Secretary belonging to the Association; to receive all bills against the Association, and pay the same, after having the approval of the President; to deliver all paid bills to the Secretary at the close of each meeting, taking a receipted statement of the same; to keep an accurate book account of all transactions pertaining to his office.

ARTICLE IV.

SEC. 1. The following persons may become members of the Association by signing the Constitution, or authorizing the President or Secretary of the Association to sign for them, and pay the initiation fee of one dollar: Any person having charge of the Mechanical Department of a Railway known as "Superintendents," or "Master Mechanics," or "General Foremen," the names of the latter being presented by their superior officers for membership, also two Mechanical Engineers, or the representative of each Locomotive Establishment in America.

SEC 2. Civil and Mechanical Engineers, and others whose qualifications and experience might be valuable to the Association, may become Associate Members by being recommended by three active members. Their names shall then be referred to a committee, which shall report to the Association on their fitness for such membership. Applicants to be elected by ballot at any regular meeting of the Association, and five dissenting votes shall reject. The number of Associate Members shall not exceed twenty. Associate Members shall be entitled to all the privileges of active members excepting that of voting.

SEC. 3. Any person who has been or may be duly qualified, and signs, or causes to be signed, the Constitution, as member of the Association, remains as such until his resignation may be voluntarily tendered.

SEC. 4. All members of the Association will be liable for such dues as may be necessary to assess to defray the expenses of the Association, and any member who shall be two years in arrears for annual dues shall have his name stricken from the roll, and be duly notified of the same by the Secretary.

ARTICLE V.

SEC. 1. The regular meeting of the Association shall be held annually on the third Tuesday in June.

SEC. 2. Regular meetings shall be held at such place as may be determined upon by a majority of the members present at the previous meeting.

SEC. 3. An adjourned meeting may be held at any time and place that a majority of the members present at any meeting may elect.

SEC. 4. The regular hours of sessions shall be from 9 o'clock A. M. to 2 o'clock P. M.

SEC. 5. During the business sessions no communications shall be received or acted upon other than those pertaining to the business of the Association.

SEC. 6. At this, the Thirteenth Annual Meeting, the President shall appoint three members to constitute a standing committee to recommend to the Association at each Annual Meeting subjects for discussion at each succeeding Convention, one member for three years, one for two years, and one for one year, designating the term of each member, and each succeeding year one member of said committee shall be elected by the Association by ballot.

The said committee shall, at one o'clock on the second day of each Annual Convention, report to the Association subjects for discussion at the succeeding Convention.

At 7:30 o'clock of the second day of each Annual Convention there shall be a joint meeting of said committee with an advisory committee, composed of the officers of the Association, which joint committee shall, at ten o'clock on the morning of the third day of each Annual Convention, nominate to the Association the members of the several committees upon said subjects. Said joint committee shall nominate, upon subjects which require reports, from various parts of the country, full committees of three or five, which committees shall be called committees of research, and shall have power to solicit reports from not all but a part of the members of the Association upon such subjects; and upon other subjects, said joint committee shall nominate simply the chairman of the committees, who shall have power to select their own associates upon such committees, which shall be called committees of investigation; said joint committee shall also nominate two Associate Members to read papers at the succeeding Annual Meeting.

All committees so appointed, whether of research or investigation, shall meet at four o'clock on the afternoon of the third day of each Annual Convention to plan and divide its work for the ensuing year.

Each committee on research shall, on or before the first day of July of each year, send to the Secretary of the Association a circular letter setting forth the character of reports desired from the members, together with a list of persons to whom said letter shall be sent; and the Secretary shall immediately print and mail the same to such members, with an earnest request that, as a matter of courtesy, full replies thereto shall be sent on or before the first day of April following, to the chairman of such committees.

Each committee, whether of research or of investigation, shall, if possible, meet pursuant to the call of its chairman, during the second week in April of each year, for the preparation of its report, which, in the absence of such meeting, shall be prepared by the chairman, and shall immediately forward the same to the Secretary of the Association, by whom it shall be printed and supplied to the members at the commencement of each Annual Convention.

Each report of such committees shall name the members of the Association from whom replies to said circular letters were requested but not received, on or before the first of April as aforesaid.

ARTICLE VI.

SEC. 1. This Constitution may be amended at any regular meeting of the Association by two-thirds vote of the members present.

Resolution Passed at the Sixth Annual Meeting, Baltimore, Maryland, May, 1873.

Resolved, That no expense shall be incurred by committees except by the unanimous consent of the General Supervisory Committee, given in writing to the Chairman of said Committee, stating the amount to be expended.

Resolution on Boston Fund, Passed at the Eighth Annual Meeting, New York, May, 1875.

Resolved, That the Boston Fund, amounting now, with accrued interest, to $3,620, be invested in Government securities to be selected by the duly appointed Trustees, and not to be disturbed for the purpose of expenditure, unless authorized by the majority of members present in open Convention and then only after due notice of a motion to expend the same has been given at the session immediately preceding; and that the interest accumulating shall every year be invested in the same manner as the principal, and a full account of the same be duly reported with other financial statements.

Resolution Adopted at the Ninth Annual Meeting.

Resolved, That members of the Association who have been in good standing for a period of not less than five years, and who through age or other cause cease to be actively engaged in the mechanical departments of railroad service, may, upon the unanimous vote of the Association, be elected "Honorary Members," who shall have their dues remitted and be entitled to all the privileges of regular members except that of voting.

NAMES AND ADDRESS OF MEMBERS.

NAME.	ROAD.	ADDRESS.
Anderson, H.	147 Randolph street	Chicago, Ill.
Anderson, J. H.	N. Y., B. & P. Rd	Providence, R. I.
Anderson, R. H.	G. & C. Rd	Helena, S. C.
Anderson, Thos	C., C. & A. Rd	Columbia, S. C.
Alden, H. A.	C., C. & B. & O. Rd	Brockville, Ont., Can.
Britton, H. M.	N. J. M. Rd	New York City.
Britton, A. W.		
Boon, J. M.	P., Ft. W. & C. Rd	Fort Wayne, Ind.
Bushnell, R. W.	B., C. & R. N. Rd	Cedar Rapids, Iowa.
Brastow, L. C.	L. & S. Rd	Ashley, Pa.
Boyden, G. E.	N. Y. & N. E. Rd	Boston, Mass.
Brooks, H. G.	Brooks Locomotive Works	Dunkirk, N. Y.
Barnett, J. Davis	Grand Trunk Rd	Montreal, Canada.
Black, John	D. & M. Rd	Lima, Ohio.
Blackwell, K.	Grand Trunk Rd	Belleville Sta., Can.
Blackall, R. C.	D. & H. C. Co	Albany, N. Y.
Baldwin, B. L.	P. & R. Rd	Danville, Ill.
Bissett, John	C. & D. Rd	Florence, S. C.
Briggs, R. H.	M. & O. Rd	Whistler, Ala.
Chapman, N. E.	C. & P. Rd	Cleveland, Ohio.
Chapman, J. W.	N. Y., L. E. & W. Rd	Hornellsville, N. Y.
Chapman, Thos. L.	C. & O. Rd	Huntington, W. Va.
Cummings, S. M.		Boston, Mass.
Coolidge, G. A.	Fitchburg Rd	Charlestown, Mass.
Clark, David	L. V. Rd	Hazleton, Pa.
Clark, Peter	N. Rd. of Canada	Toronto, Canada.
Cooper, H. L.	L., E. & W. Rd	Lafayette, Ind.
Cook, James	Danforth & Cook's Locomotive Works	Paterson, N. J.
Cushing, George	M., K. & T. Rd	Sedalia, Mo.
Crockett Jno. F.	B., L. & N Rd	Boston, Mass.
Cory, Chas. H.	S. V. Rd	Portsmouth, Ohio.
Coon, Geo. F.	M. R. Rd	Hancock, Mich.
Colburn, Richard	N. & W. Rd	Norwich, Conn.
Clifford, J. G.	I. M. Rd	Paris, Ill.
Crowell, Nathan	L. & O. Rd	Peru, S. A.
Cook, John S.	Georgia Rd	Augusta, Ga.
Cook, Allen	C. & E. I. Rd	Danville, Ill.
Devine, J. F.	W. & W. Rd	Wilmington, N. C.
Dripps, W. A.	3324 Walnut street	Philadelphia, Pa.

NAME.	ROAD.	ADDRESS.
Elliott, Henry		E. St. Louis, Mo.
Edams, J. B.	I. C. Rd	Amboy, Ill.
Ellis, J. C	Schenectady Locomotive Works,	Schenectady, N. Y.
Ellis, W. H.	P. & R. Rd	Catawissa, Pa.
Everson, Thos.	St. L., S. & L. Rd	Steeleville, Mo.
Eckford, Jas.	C., H. & D. Rd	Cincinnati, Ohio.
Eastman, A. G	S. E. Rd	Richford, Vt.
Ennis, W. C.	M. Rd	Wortendyke, N. J.
Foss, J. M	C. V. Rd	St. Albans, Vt.
Fry, Howard	P. & E. Rd	Williamsport, Pa.
Flynn, J. H	W. & A. Rd	Atlanta, Ga.
Fuller, William	N. Y., P. & O. Rd	Cleveland, Ohio.
Faries, H. V.	A. T. & S. F. Rd	Topeka, Kansas.
Finlay, L	C. & F. Rd	Little Rock, Ark.
Foster, W. A	W. & M. Div. F. Rd	Fitchburg, Mass.
Fowle, I. W	C., C., C. & I. Rd	Delaware, Ohio.
Gordon, H. D	P., W. & B. Rd	Wilmington, Del.
Graham, Chas.	L. & B. Rd	Kingston, Pa.
Gilson, Gregg D.	Capiopa Rd	Chili, S. A.
Gordon, Alex.	Niles Tool Works	Hamilton, O.
Gordon, James T.	Concord Rd	Concord, N. H.
Hayes, S. J	Ill. Cent. Rd	Chicago, Ill.
Holloway, J. W.	C., Mt. V. & D. Rd	Akron, Ohio.
Hain, F. K	Elevated Rd.	New York City.
Ham, C. T	Buffalo Steam Gauge Co	Rochester, N. Y.
Hewitt, John	M. P. Rd	St. Louis, Mo.
Haynes, O. A	St. L. & I. M. Rd	Carondelet, Mo.
Hollister, C. W	Valley Rd	Hartford, Conn.
Hodgman, S. A.	P., W. & B. Rd	Wilmington, Del.
Haggett, J. C.	D., A. V. & P. Rd.	Dunkirk, New York
Hanson, C. F.	D. & M. Rd	Detroit, Mich.
Hewitt, W. O	T., P. & W. Rd	Peoria, Ill.
Hackney, George	A., T & S. F. Rd	Topeka, Kansas.
Hackney, C	A., T. & S. F. Rd	Topeka, Kansas.
Howson, N. W	C. & R. Rd	Mt. Savage, Md.
Hollister, J. D.	S., F. & W. Rd	Savannah, Ga.
Ivanson, J	C. S. Rd	Ludlow, Ky.
Johann, Jacob	W. & St. L. Rd.	Springfield, Ill.
Jackman, J. A	C., A. & St. L. Rd	Bloomington, Ill.
Jeffery, E. T	I. C. Rd	Chicago, Ills.
Jacques, Richard	Capiopa Rd	Chili, S. A.
Johnson, J. B	A. C. Rd	Helena, Ark.

NAME.	ROAD.	ADDRESS.
hnson, F. W.	Sp., J. & P. Rd	Springfield, Ohio.
nsey, J. I,	L. V. Rd	Easton, Pa.
ɔeler, Sanford	F. & P. M. Rd	East Saginaw, Mich.
lby, G. S.	C. & P. Rd.	Lyndonville, Vt.
ɯfholz, F. G.	C., C., C. & I. Rd	Cleveland, Ohio.
ng, Robert	W. & A. Rd	Montgomery, Ala.
ɪsey, Jacob	Steam Forge Co	New Albany, Ind.
.uder, J. N	N. Rd of N. H.	Concord, N. H.
ech, H. L.	Hinkley Locomotive Works	Boston, Mass.
.nnon, Wm	House of Representatives	Washington, D. C.
ɛwis, W. H.	D., L & W. Rd.	Kingsland, Pa.
ɛvis, J. M.	S. M. & M. Rd	Marion, Ala.
ulligan, John	Connecticut River Rd	Springfield, Mass.
itchell, A	W. Div. L. V. Rd	Wilkesbarre, Pa.
orse, G. F.	Portland Locomotive Works.	Portland, Me.
ead, Lyell T.	C., F. & W. Rd	Chippewa Falls, Wis.
arten, John E	C., C. & T. Rd	Chili, S. A.
aglenn, James	C. C. Rd	Laurinsburg, N. C.
cKenna, J.	I., P. & C. Rd	Peru, Ind.
cFarland, John	C. & O. Rd	Richmond, Va.
cCrum, J. S	M. R., Ft. S. & G. Rd	Kansas City, Mo.
cVey, John	A. G. S. Rd	Chattanooga, Tenn.
cAlpine, A. R	Ind. Div. C., C., C & I. Rd	Brightwood, Ind.
iller, Wm. H.	Transfer & Stock Yard Co	Indianapolis, Ind.
inshall, E.	N. Y., O. & W. Rd.	
ɔyes, Warren E	E. Div. G. T. Rd	Gorham Sta., N. H.
tton, John.	C. S. Rd	St. Thomas, Canada.
ndleton, M	S. & R. Rd	Portsmouth, Va.
·rry, F. A	C. & A. Rd	Keene, N. H.
ɪrrin, P. J	Taunton Locomotive Works	Taunton, Mass.
ddle, C. R.	T. H. & I. Rd	Terre Haute, Ind.
escott, G. W.	C. & St. L. Rd	St. Louis, Mo.
ilbrick, J. W	M. C. Rd	Waterville, Me.
escott, G. H.	P. C. & St. L. Rd	Logansport, Ind.
ɪrves, T. B.	W. Div. B. & A. Rd	Greensburg, N. Y.
ace, T. W	Ill. Cent. Rd	Waterloo, Ill.
llsbury, Amos	Eastern Rd	Salem, Mass.
lson, S. S		Louisville, Ky.
·ice, Thos		Ludlow, Ky.
.tterson, J. S.	C. I., St. L. & C. Rd	Cincinnati, O.
ɪrry, Chas. T.	Baldwin Locomotive Works	Philadelphia, Pa.
ɪnson, Thomas W.		Mattoon, Ill.

NAME.	ROAD.	ADDRESS.
Ray, W. T.	T. W. & W. Rd	Fort Wanye, Ind
Richards, Geo	B. & P. Rd	Boston, Mass.
Robb, W. D.	L. P. & S. M. Rd	Elizabethtown, Ky.
Reynolds, G. W	O. C. Rd., (N. Div.)	Taunton, Mass.
Robertson, Thomas	M. P. & C. Rd	Marietta, O.
Schaeffer, August		Louisville, Ky.
Smith W. T.	P. & E. Rd	Erie, Pa.
Smith, Allison D	Government Rd	New Zealand.
Strode James	E. & C. Div., N. C. Rd	Elmira, N. Y.
Stearns, W. H.	Connecticut Rd	Springfield, Mass.
Shaver, D. O.	Pennsylvania Rd	Pittsburgh, Pa.
Setchel, J. H	K. C. Rd	Cincinnati, O.
Sedgley, James	L. S. & M. S. Rd	Cleveland, O.
Sanborn, A. J		Mattoon, Ill.
Stevens, G. W	L. S. & M. S. Rd	Elkhart, Ind.
Sprague, H. N	E. K. Porter & Co	Pittsburgh, Pa.
Salisbury L. B	St. L. & S. E. Rd	Mt. Vernon, Ill.
Selby, W. H	St. L., K. C. & N. Rd	Moberly, Mo.
Simonds, G. B.	C. & St. L. Rd	East Carondelet, Ill.
Small, Robert	I. & G. N. Rd	Palestine, Texas.
Sitton, B. J	S. R. & D. Rd	Selma, Ala.
Swantson, Wm.	J. M. & I. Rd	Jeffersonville, Ind.
Spittle, W	Valley Rd	Cleveland, O.
Steel, W. J	L. N. & Gt. S. Rd	Nashville, Tenn.
Twombly, T. B.	C. R.. I. & P. Rd	Chicago, Ill.
Turriff, W. F	C. C. C. & I Rd	Cleveland, O.
Towne, H. A	N. P. Rd	Brainerd, Minn.
Taylor, J. K	O. C. Rd	Boston, Mass.
Tull, C. H	V. S. & T. Rd	Monroe, La.
Thumser, John	O. & M. Rd	Seymour, Ind.
Thomas, W. H		
Underhill, A. B	B. & A. Rd	Springfield, Mass.
Van Vetchen J	N. Y., L. E. & W	Susquehanna, Pa.
Watrows, Geo. C	D., L. & N. Rd	Iona, Mich
West, Geo. W	S. C. & N. Y. Rd	Syracuse, N. Y.
West, Thomas	N. Y., & L. E. & W. Rd	Buffalo, N. Y.
Walsh, Thomas	N. & O. of L. & N. Rd	Memphis, Tenn.
Warren, B	St. L., A. & T. H. Rd	St. Louis, Mo.
Woods, H. E	C., R. & P. Rd	Rock Island, Ill.
Wells, Reuben	L. & N. Rd	Louisville, Ky.
Wiggins, J. E.	H. E. & W. T. Rd	Houston, Texas.
Waite, F. A.	B. & M. Rd	Boston, Mass.

ME.	ROAD.	ADDRESS.
›ck, W.	Central R. R. of N. J.	Elizabethport, N. J.
J. L		Evansville, Ind.
ıs, E. H.	Baldwin Locomotive Works	Philadelphia, Pa.
, D. L	E. K. Rd	Hunnewell, Ky.
Phillip.	C. & P. Rd	Wellsville, O.
F. M.	N. Y., L. E. & W. Rd	Susquehanna, Pa.
ıan, D. A.	Pittsburgh Locomotive Works	Cleveland, O.
, John W		
L. S		Cleveland, O.

ASSOCIATE MEMBERS.

Alex. L.	273 Broadway	New York City.
'. B		Philadelphia.
, Henry	Professor, Stevens' Institute	Hoboken, N. Y.
ıd, J. H,	Western R. R. Association	Chicago, Ill.
Coleman		Philadelphia, Pa.
›n, R. H.	Professor, Stevens' Institute	Hoboken, N. J.
ck, Jerome		Worcester, Mass.
Chas. A.	Washington University	St. Louis, Mo.
'. O. D		Indianapolis, Ind.
›hn W		Cincinnati, O.
M. N	73 Broadway	New York City.
W. W	66½ Pine street	New York City.

HONORARY MEMBERS.

Isaac	3405 Walnut Street	Philadelphia, Pa.
›n, W. A		Hamilton. Canada.

OBITUARY.

Mr. B. J. GREGG, late Master Mechanic of the Cleveland, Sandusky & Cincinnati Railroad, was born October 26, 1836, and died July 31, 1880.

Mr. Gregg commenced railroading at a very early age, and was first employed on what was then called the Mad River Railroad, running from Sandusky to Dayton, although in what capacity we are unable to say, but he was employed as a practical engineer on the same road at the age of 21, and also on the Little Miami Railroad in the same capacity from 1863 to 1868, when he returned to the Mad River Railroad, and continued there as an engineer until July 10, 1872, when he was made foreman of the Cleveland, Sandusky & Cincinnati Railroad shops, and March 31, 1877, was appointed Master Mechanic of the Cleveland, Sandusky and Cincinnati Railroad, which position he held up to the time of his death.

Mr. Gregg was a faithful man in all his relations, and highly appreciated by the officers of his Company. He leaves a wife, son, and daughter, to mourn his loss, to whom we would express the sincere sympathy of this Association.

Respectfully submitted,

J. H. SETCHEL,
JAMES ECKFORD, } *Committee.*
J. H. PATTERSON,

On the Death of John Swift.

The printing of the Report having been detained waiting for report of Committee appointed to prepare a paper on the death of Mr. SWIFT, the Secretary has selected the following from the local press where Mr. Swift resided, accompanied by resolutions of respect from

the employes of the Locomotive Works where he spent the latter portion of his life:

"OBITUARY OF JOHN SWIFT.

"The news Sunday morning of the death of the Superintendent of the Locomotive Works was a great surprise to most residents who knew nothing of his sudden sickness. Mr. Swift was taken sick, we, learn last Wednesday. His complaint proved to be what is known as gall stone, an exceptional, painful, and dangerous malady. Mr. Swift having been for years a nervously active and very industrious man, his system had been so taxed and exhausted that strength for physical reaction failed him. Saturday his condition was reported as very critical, and the worst fears were realized next morning, when he passed away in the full possession of his faculties, after periods of great suffering and past unconsciousness. The best medical skill of this city and Albany proved of no avail in saving life.

"The deceased was in the very prime of life and usefulness. He came here about five or six years since from Scranton, Pennsylvania, fully versed in the management of locomotive works, and took the place here long filled as Superintendent by Walter McQueen. For a couple of years afterwards the works were either closed or running at times very short-handed, owing to the prolonged business depression of the land. Since the return of better times, Mr. Swift has been indefatigable in the performance of duty, even to the most minute details. This busy disposition caused his acquaintance with many residents to be of a passing kind, but to all with whom he was brought directly in contact his desire to please was very plain, and, it may be added, was quite successful. His loss to the Locomotive Works is a very serious one, and is especially felt by the managers. To his widow and three fatherless children of tender years, the stroke must be poignant and irreparable. Such sympathy as can be given in a case of its kind is freely extended, and is small enough when compared with the solace of Divine promises.—*Star.*"

"RESOLUTIONS OF RESPECT.

"At a meeting of the employes of the Schenectady Locomotive Works, held at the office of the Company, on the 3d inst., the following resolutions were adopted:

"WHEREAS, In the dispensation of an All-wise Providence, our late Su-

perintendent, John Swift, has been suddenly removed from our midst by death, we take this opportunity of expressing our sorrow.

"*Resolved*, That in Mr. Swift we ever realized a skillful Superintendent, endeared to us by all his uniform urbanity and kindness, winning our esteem and kindliest sentiments, his loss under such trying and painful circumstances we most deeply deplore; the remembrance of his genial presence and kindly address will long linger in our memories.

"*Resolved*, That we extend our heartfelt sympathy to his bereaved family in this the hour of their deep affliction.

"*Resolved*, That we attend the funeral in a body, thereby uniting in paying our last sad tribute of respect to his memory.

"*Resolved*, That the proceedings of this meeting be published in the city papers, and that a copy of the same be transmitted to his family.

"GEORGE ELLIS,
"CHARLES F. PAGE,
"JAMES ORCHARD,
"JOHN DERBYSHIRE,
"FRANK WILLIAMSON,
"GEORGE S. CLARE,

Committee."

ORDER OF BUSINESS.

1. Reading the Minutes of the previous meeting.
2. Calling the Roll of Members.
3. Signing the Constitution.
4. Report of Secretary.
5. Report of Treasurer.
6. Report of Committees appointed at a previous meeting.
7. Election of Officers.
8. Appointment of a Committee to suggest Subjects for Consideration.
9. Appointment of Miscellaneous Committees: Finance, Printing, and Place of Holding Next Annual Meeting.
10. Report of Committee to suggest Subjects for Consideration.
11. Appointment of Committees to report upon Subjects suggested for Consideration.
12. Unfinished Business.

J. N. LAUDER,
R. WELLS,
JAMES SEDGLEY,
S. J. HAYES,
J. H. SETCHEL,
Committee.

INDEX.

REPORT OF PROCEEDINGS

OF THE

FIFTEENTH ANNUAL CONVENTION

OF THE

American Railway Master Mechanics'

ASSOCIATION,

In Convention at the International Hotel,

NIAGARA FALLS,

June 20, 21, and 22, 1882.

CINCINNATI:
WM. STACH, BALDWIN & CO.,
Railway Printers and Manufacturing Stationers.
1882.

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AMERICAN

RAILWAY MASTER MECHANICS' ASSOCIATION.

OFFICERS FOR 1882-88:

President,

REUBEN WELLS, OF LOUISVILLE, KY.

First Vice-President,

JAMES SEDGELEY, OF CLEVELAND.

Second Vice-President,

HOWARD FRY, OF NEW YORK.

Treasurer,

S. J. HAYES, OF CHICAGO.

Secretary,

J. H. SETCHEL, OF CINCINNATI.

REPORT.

THE FIFTEENTH ANNUAL CONVENTION OF THE AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION was held at the International Hotel, Niagara Falls, June 20th, 21st and 22d, 1882.

The Convention was called to order by the President, J. N. LAUDER, of Concord, N. H., and the proceedings were opened with prayer, by the REV. JOHN S. BACON.

On motion, the reading of the minutes of the last meeting was dispensed with.

The Secretary then called the roll, and the following members answered to their names:

LIST OF MEMBERS PRESENT.

NAME.	ROAD.	ADDRESS.
ANDERSON, H	No. 204 Dearbon street	Chicago, Ill.
BOON, J. M	Chicago & North Western	Chicago, Ill.
BUSHNELL, R. W	Burlington, Cedar Rapids & Northern	Cedar Rapids, Iowa.
BOYDEN, G. E		Boston, Mass.
BROOKS, H. G	Brooks Locomotive Works	Dunkirk, N. Y.
BLACK, JOHN	Cincinnati, Hamilton & Dayton	Lima, Ohio.
BLACKALL, R. C	Delaware and Hudson Canal Co	Albany, N. Y.
BRIGGS, R. H	Mobile & Ohio	Whistler, Ala.
COOLIDGE, G. A	Fitchburg.	Charlestown, Mass.
COOPER, H. L	Lake Erie & Western	Lafayette, Ind.
COOK, JAMES	Danforth & Cook's Locomotive Works	Paterson, N. J.
COOK, ALLEN	Chicago & Eastern Illinois	Danville, Ill
CLARK, PETER	Northern of Canada	Toronto, Canada.
CLIFFORD, J. G	Illinois Midland	Paris, Ill.
DEVINE, J. F	Wilmington & Weldon	Wilmington, N. C.
EASTMAN, A. G	South-Eastern.	Richford, Vt.
ENNIS, W. C,	New York, Lackawanna & Western	Wortendyke, N. J.
FRY, HOWARD	New York, West Shore & Buffalo	New York.
FLYNN, J. H	Western & Atlantic	Atlanta, Ga.
FOSTER, W. A	W. & M. Division Fitchburg	Fitchburg, Mass.

NAME.	ROAD.	ADDRESS.
FULLER, WILL.	New York, Pennsylvania & Ohio	Cleveland, O.
HAYES, S. J	Illinois Central	Chicago, Ill.
HAM, C. T.	Buffalo Steam Gauge Co	Rochester, N. Y.
HAGGETT, J. C.	Dunkirk, Allegheny Valley & Pittsburg	Dunkirk, N. Y.
HACKNEY, GEORGE	Atchison, Topeka & Santa Fe	Topeka, Kansas.
HOLLISTER, J. D.	Savannah, Florida & Western	Savannah, Ga.
JOHANN, JACOB	Wabash, St. Louis & Pacific	Springfield, Ill.
KENT, WILL	Shoenberger & Co	Pittsburgh, Pa.
KILBY, G. S.	Cumberland & Pennsylvania	Lyndonville, Vt.
LAUDER, J. N.	Northern of New Hampshire	Concord, N. H.
LEECH, H. L.		No. 1 Rollins street, Boston, Mass.
LANNON, WM	House of Representatives	Washington, D. C.
LEWIS, W. H.	Delaware, Lackawanna & Western	Kingsland, N. J.
MAGLENN, JAS	Cheraw & Chester	Laurensburg, N. C.
McKENNA, J	Indianapolis, Peru & Chicago	Peru, Ind.
MINSHALL, E.	New York, Ontario & Western	Middletown, N. Y.
PENDLETON, M	Seaboard & Roanoke	Portsmouth, Va.
PERRIN, P. J	Taunton Locomotive Works	Taunton, Mass.
PRESCOTT, G. H.	Pittsburgh, Cincinnati & St. Louis	Logansport, Ind.
PLAYER, JOHN	Central of Iowa	Marshalltown, Iowa.
PRINGLE, R. M.	St. Louis & Cairo	St. Louis, Mo.
RAYMOND, J. H.	Western Railroad Association	Chicago, Ill.
ROBINSON, W. A.		Hamilton, Canada.
RICHARDS, GEORGE	Boston & Providence	Boston, Mass.
SMITH, W. T	Philadelphia & Erie	Erie, Pa.
SETCHEL, J. H.	No. 1109 Eastern Avenue	Cincinnati, O.
SEDGLEY, JAMES	Lake Shore & Michigan Southern	Cleveland, O.
SANBORN, A. J.		Mattoon, Ill.
SIMMONDS, G. B.	Cairo & St. Louis	East Carondelet, Ill.
SMITH, CHAS. A.	Washington University	St. Louis, Mo.
SPRAGUE, H. N.	H. K. Porter & Co	Pittsburgh, Pa,
SWANSTON, WILL	Jeffersonville, Madison & Indianapolis	Jeffersonville, Ind.
TWOMBLY, T. B.	Chicago, Rock Island & Pacific	Chicago, Ill.
TURRIFF, W. F.	Cleveland, Columbus, Cin'ti & Ind.	Cleveland, O.
WATROUS, GEO. C.	Detrroit, Lansing & Northern	Iona, Mich.
WARREN, B.	St. Louis, Alton & Terre Haute	St. Louis, Mo.
WOODCOCK, W	Central of New Jersey	Elizabethport, N. J.
WILDER, F. M.	New York, Lake Erie & Western	Susquehanna, Pa.
WEST, THOMAS	New York, Lake Erie & Western	Buffalo, N. Y.
WIGHTMAN, D. A.	Pittsburgh Locomotive Works	Pittsburgh, Pa.

The Secretary read Article IV of the Constitution, reciting the qualifications for membership.

A recess was then taken to enable persons qualified and wishing to join the Association to sign the Constitution.

The following names were added to the roll of members:

LIST OF NEW MEMBERS.

NAME.	ROAD.	ADDRESS.
ARDEN, D. D	Central of Georgia	Savannah, Ga.
BRYAN, H. S.	Chicago & Iowa	Aurora, Ill.
BARTON, J. C	Hartford & Connecticut Valley	Hartford, Conn.
BROWNELL, F. G.	Burlington & Lamoille	Burlington, Vt.
BRADLEY, S. D.	Grand Rapids & Indiana	Grand Rapids, Mich.
BRIGHAM, L. L.	Passumpsic	Lyndonville, Vt.
DURGIN, J. A.	Rhode Island Locomotive Works	Providence, R. I.
DOMVILLE, C. K	Great Western of Canada	Hamilton, Canada.
GRAHAM, J. S.	Lake Shore & Michigan Southern	Buffalo, N. Y.
HOWE, GEO.	St. Johnsbury & Lake Champlain	St. Johnsbury, Vt.
HENNY, J. B.	Wisconsin Central	Stevens Point, Wis.
HENNY, Jr., JOHN	New York, New Haven & Hartford	Hartford, Conn.
HOVEY, J. P.	Rochester and Pittsburg	Rochester, N. Y.
MORRILL, J. E.	Chicago, Rock Island & Pacific	Davenport, Iowa.
PORTER, J. L	Indiana, Bloomington & Western	Sandusky, O.
ROSS, GEO. B.	New York, Lake Erie & Western	Buffalo, N. Y.
SHORT, WILLIAM A.	Canada Southern	St. Thomas, Ontario.
WARREN, W. B.	Ohio Southern	Springfield, O.
WHITE, C. W.	Louisville & Nashville	Birmingham, Ala.

Upon the Convention being called to order, the President, Mr. James N. Lauder, delivered his annual address, as follows:

PRESIDENT'S ADDRESS.

GENTLEMEN OF THE ASSOCIATION:

For the fifteenth time we meet in convention to transact the necessary routine business of the Association, and to hear and discuss the reports of the various committees.

These committees will present, for consideration, reports on questions of interest not only to you as individuals and members of this Association, but of vast interest to the railroads with which you are

connected and which you serve. The quality of the papers presented, and the manner in which you act upon them, is what gives value to our deliberations; and when the fact is considered that the expense of the motive power department of the railroads of this country is above 25 per cent. of the total expense of operation, it will be seen how necessary it is for us to come to correct conclusions in matters that may come before us. Ten years' investigations and experience has enabled us to reduce the expense of maintenance of motive power by more than one-half; and I think I may safely claim that this result has been accomplished in a great measure by the investigations of this Association, and the diffusion of technical knowledge by the discussions at our annual meetings, and by sending our printed reports broad-cast over the whole country.

The railway system of this country is being developed so rapidly, and competition is becoming so sharp that the prime necessity in railway management is economy of operation, and the man who can run his department the cheapest, other things being equal, will steadily and surely come to the front. Bearing this in mind it will be seen that plainness and simplicity of construction must be the watchword, ignoring every thing that tends to complication, unless such complication brings about desirable results that can not otherwise be obtained.

Technical knowledge in our profession is what most of us lack. Practical knowledge we have gained by long years of experience, and this Association is capable and does give us the scientific knowledge we stand so much in need of. The past year has brought changes to many of our members, and it is with pride that I can say that these changes have uniformly been promotions; but I am pained to inform you that death has invaded our ranks and taken from us five of our most valued members within the year, viz: W. S. Hudson, W. Spittle, Wm. Rushton, H. E. Woods and A. L. Holley. The latter an Associate Member.

Without being invidious, I think, a word here of tribute to the memory of the late Mr. Hudson may not be out of place. He was by his age, experience, rare ability and good qualities of head and heart the peer of any of us, and his death will be an irreparable loss to the Association as well as a personal loss to each individual member. I trust the Association will take action expressive of our feelings for the loss of our late associates.

The past year has been a remarkable one in the annals of railway construction. Lines have been pushed in all directions from the St. Lawrence river on the North to the Rio Grande on the South, and from the Atlantic ocean to the Pacific. American enterprise has even invaded the territory of our sister republic, Mexico, and hundreds of miles of railway are already in operation within her borders, and before another year rolls around her railway system will aggregate thousands of miles. The locomotive is the great civilizer of the age, and we may expect to see, at no distant day, emigration from the crowded Eastern States and from Europe following the locomotive into Mexico and making that fertile country blossom as of old.

It gives me pleasure to see so large an attendance at our opening session. It is testimony conclusive that the Association and the objects for which it was formed are still paramount in the minds of its members, and the interest you manifest by your presence will, I am sure, carry it forward in its career of usefulness to yourselves and to the interests you serve.

While occupying the position of President of this Association for the past two years, I have served you to the best of my ability, and on the occasion of my retirement from this position I desire to thank you for the uniform courtesy I have received at your hands, and for the leniency with which my mistakes have been treated while presiding at your annual conventions.

THE PRESIDENT—Before we hear the report of our Secretary I have a communication which I would like to read, that will be of interest to the lady friends of the Association.

To the President, officers and members of the American Railway Master Mechanics' Association, their friends and guests:

The Entertainment Committee beg to extend to you the freedom of Niagara Falls, as per the printed programme placed in your hands. In calling for carriages you are particularly requested to make your application only to the hotel office, or to the superintendent of carriages at the hotel, as the tickets are not available for any other carriages. The Committee beg that you will all feel the most perfect freedom to call for carriages at any time, as ample provision has been made for this purpose. It will be necessary for each per-

son to have the card of invitation accompanying the programme with him constantly.

H. G. BROOKS, *Chairman.*

THE PRESIDENT — Members and their friends will govern themselves accordingly. The next business in order will be the reading of the report of the Secretary.

Mr. Setchell then presented

THE SECRETARY'S REPORT.

To the American Railway Master Mechanics' Association :

GENTLEMEN — Herewith I present a detailed statement of the condition of the Association for the year ending with this our Fifteenth Annual Convention.

Since last report the following gentlemen have become members of the Association :

NAME.	ROAD.	ADDRESS.
EASTMAN, A. G	South-Eastern	Richford, Vt
ENNIS, W. C	Midland of New Jersey	Wortendyke, N. J.
GORDON, ALEX	Niles Tool Works	Hamilton, O.
HOWSON, N. W	Cumberland & Pennsylvania	Mt. Savage, Md.
HOLLISTER, J. D.	Savannah, Florida & Western	Savannah, Ga.
KENT, WILLIAM, M. E.	Schoenberger & Co.	Pittsburgh, Pa.
LYNE, LEWIS F., M. E.	American Machinist	New York City.
LEVIS, J. M	Selma & Greensboro	Marion, Ala.
MINSHALL, E	New York, Ontario & Western	Middletown, N. Y.
PRINGLE, R. M	St. Louis & Cairo	St. Louis, Mo.
PLAYES, JOHN	Central of Iowa	Marshalltown, Iowa.
STONE, HENRY B	Chicago, Burlington & Quincy	Aurora, Ill.
THAW, WILLIAM	South Australian	Adelaide, Aus.

The following members have, by the rules of the Association, forfeited their membership on account of the non-payment of dues, and their names have been stricken from the rolls : Thomas Anderson, H. V. Faries, R. D. Grant, W. E. Granger, E. O. Hill, A. S. Hull, Thomas Lingle, W. H. Lewis, John McKenzie, Gordon H. Nott, N. Slingland and E. Sleppy.

The following members have resigned : W. B. Bement, B. L.

n, F. K. Hain, Lyell T. Mead and Warren Noyes; and, re last met, the following members have been called away by A. L. Holley, W. S. Hudson, William Rushton, W. Spittle . E. Woods, which changes leave the present membership ring 188.

lve hundred copies of the Fourteenth Annual Report have rinted, 254 of which have been distributed to members, and Railroad Companies, Locomotive Works and others, leaving pies still on hand.

following is a statement of money received from Railroad nies and others contributing to the Printing Fund:

d & Roanoke		$5 00
Central		10 00
icut River		10 00
& Providence		10 00
hore & Michigan Southern		10 00
re, Lackawanna & Western		10 00
rk, Lake Erie & Western		10 00
nnessee, Virginia & Georgia		10 00
& Ohio		10 00
& Eastern Illinois		10 00
i Pacific		10 00
Valley		10 00
n of New Hampshire		10 00
is & Iron Mountain		10 00
Lowell & Concord		10 00
ati, Cleveland & Columbus		10 00
n, Topeka & Santa Fe		10 00
Southern		10 00
and Steam Gauge Co		50 00
& Dreyfus, New York		20 00
Locomotive Works		50 00
Locomotive Works		10 00
n Locomotive Works		10 00
tady Locomotive Works		10 00
rgh Locomotive Works		10 00
orter & Co		10 00
ool Works, Hamilton, O		10 00
Evans, New York City		10 00
Total amount of Contributions		$365 00
t received by Assessment		730 00
t received by Initiation		8 00
t received by R. R. Gazette	$50 00	
t received by R. R. G. Sales of Reports	22 95	72 95
Making the total amount received		$1,175 95

which I hold the Treasurer's receipts.

THE BOSTON FUND,

Consisting of thirty-seven hundred Four Per Cent. Bonds, with accrued interest, amounts as follows:

Intererest and amount unapplied at last Report, including Cleveland Donation	$369 51
July Interest, 1881	37 00
October Interest, 1881	37 00
January Interest, 1882	37 00
April Interest, 1882	37 00
Total interest and amount unapplied	$517 51
Which amount added to the principal	3,700 00
Shows the present value of the original Boston Fund	$4,217 51

In this connection permit me to say just a few words in regard to myself. With the close of this Convention I will have been your Secretary for twelve years, and I beg you will do me the justice to believe that it is with no ordinary feeling of regret that I say to the members that I shall not again be a candidate for the office of Secretary. I make this known early in the Convention that the members may be prepared to unite upon some one to fill the place who will in some degree familiarize himself with the work before the Convention closes. As the immediate custodian of the Boston Fund, and other property of the Association, I would say that it is in order and ready to be delivered to my successor.

Very respectfully,

J. H. SETCHEL, *Secretary.*

On motion, the Secretary's Report was accepted. After which the Treasurer's Report was submitted, as follows:

TREASURER'S REPORT.

S. J. HAYES, Treasurer, in account with

THE AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION.

1881.		Dr.	1881.		Cr.
June 16,	Balance on hand	$730 87	June 16,	No. 1, Amt. Salary to Secretary	$600 00
June 16,	Cash from Secretary	316 00	June 16,	" 2, " Reporter's Bill	69 50
			June 16,	No. 3, Amt. Wilstach, Baldwin & Co.'s Bill	653 10
1882.			June 16,	No. 4, Amt. Wilstach, Baldwin & Co.'s Bill	4 50
June 19,	Cash from Secretary	859 95	June 16,	No. 5, Amt. Cincinnati Safe Deposit Company	15 00
			June 16,	No. 6, Amt. Postage, for Books, &c.	50 50
				Balance on hand	514 22
		$1,906 82			$1,906 82

Respectfully submitted,

S. J. HAYES, Treasurer.

The Treasurer's Report was, on motion, accepted.

THE PRESIDENT—It is usual, at this time, to appoint a committee on finance—more properly speaking, a collecting committee, and also an auditing committee to examine and audit the accounts of the Secretary and Treasurer. What is your pleasure in the matter?

Mr. HAYES, Illinois Central Railroad—I move that the committees be appointed.

The motion was carried.

THE PRESIDENT—The next business in order, gentlemen, will be the reading of the report on Improvements in Boiler Construction. There is a paper in the hands of the Secretary, written by Mr. Wells, Chairman of the Committee, and there will also be one by Mr. Johann, who is a member of the Committee, but who will not be present until to-morrow. The paper of Mr. Wells will now be read.

The Secretary then read the following report, from the Chairman of the Committee, Mr. Reuben Wells, of the Louisville & Nashville Railroad:

Report of Committee of Research on Improvements in Boiler Construction.

To the American Railway Master Mechanics' Association:

GENTLEMEN—A meeting of the Committee on Boilers was called by the Chairman, to meet in Louisville, November 22d, 1881, but owing to business engagements only Mr. Johann and the Chairman of the Committee were able to attend. After some correspondence with the different members it was agreed that each should make his own report to the Convention in such form as he saw proper.

The demands of business prevented me from giving the subject sufficient time during the past year to collect the data for a report, or the results of the tests and investigations made by others, and I forward this communication with the object of calling attention to a few points and eliciting discussion rather than as a report. Reports have been made heretofore covering nearly or quite all matters pertaining to the subject of the best material form and proportions for locomotive boilers, and there seems to be but little matter that has not already been brought to your notice in reports and the different points discussed.

As regards material in the construction of boilers, the use of the best quality of homogeneous steel, as now made by our manufacturers in this country, leaves but little more to be desired. Yet, notwithstanding its excellent quality, we are not entirely free from ruptured

ide sheets in the larger class of locomotive boilers, where the box deep and water used such as deposits a hard scale on the sheets. 'he fault, in most cases of failure, is not with the material, but ather that it is required to stand what in the nature of things may e said to be impossible—strains from compression and elongation eyond the elastic limit, without final rupture. That fire-box sheets, nder circumstances frequently occurring, are subject to such trains, was, I think, conclusively demonstrated in a series of tests nade by the writer and published in the Tenth Annual Report. 'he formation of scale on the sheet increases the expansion of the netal by allowing it to attain a higher temperature than it otherwise would, developing strains in the sheet that sometimes produce permanent elongation or shortening, as the case may be, in a comparatively small section of the sheet, and when the temperature ecomes uniform in all parts of the sheet, the part under tensile train is liable to rupture, beginning always at a stay-bolt hole, but xtending through the sheet between the stay bolts, as likely, when nce started, as from one hole to another.

On some of the divisions of the road with which I am connected, large number of engines have been in service more than ten years, loing heavy work, and not five per cent. of the steel fire-box sheets n them have cracked during that time. The water used in these boilers is such that hardly any scale is formed on the sheets. More than eighty per cent. of these engines have their original fire boxes, which are still sound and apparently good. On several other divisions the case is somewhat different, more particularly the St. Louis Division, north of the Ohio river, through the State of Illinois, where the water used is more or less impregnated with lime and other impurities, forming a hard scale, and, in consequence, reducing the life of the fire boxes to about one-half of that in the case of engines on most of the divisions south of the river.

The character of the water used in a boiler, as regards the deposits left in it from evaporation, determine, to a great extent, the durability of the fire-box sheets and tube ends. Yet, with the best quality of water, a fire box has its day. It perishes, however, from a different disorder than the one in a boiler supplied with water that deposits a heavy scale. In the former case the flanges of the flue sheets, and back sheet from the top of the grate to about 36 inches

up, are the points that ordinarily give out first; the flanges become overheated or burned and crack from the rivet out, and the cracks gape open and leak.

The sheets also become thin, at the corners below the grate, from corrosion, while in its other parts the fire box remains sound.

In the latter case the life of the fire box is too short for producing this effect on the flanges of flue and back sheets, as the side sheets give out at the stay bolts from cracks extending from them to a greater or less distance, until renewal becomes necessary.

It is important, in all cases, that the flanges of fire-box sheets be as short as possible. The closer the seam is to the corner the longer it will last; it remains cooler than if more exposed to the effects of the fire. I have noticed a number of flue and back sheets, within the past two years, that had to be removed simply on account of the burning and cracking of their flanges, that were otherwise good for several years' service, and many more that must soon be removed from the same cause. The flanges were originally made too long, extending out from the face of the sheet as much as three inches. Had they been made but two inches they would doubtless have lasted much longer.

This is a matter, which from my observation, I conclude is very often overlooked in the construction of the fire box. All laps exposed to the fire should be as short as possible, more particularly where the heat is great. The flanges, if properly turned, need not at most be more than two inches from the face of the sheet in the vertical seams for a distance of two or three feet above the grate; a lap of $1\frac{3}{4}$ inches for the seam is sufficient at that place. At greater distances from the grate the lap and length of flange may be greater without any evil results. I have noticed, also, many cases where tube sheets were much worn around the end of the tube, in the form of a countersink about one-quarter of an inch wide and the same in depth, around the lower and central tubes, the sheets becoming so thin as to require removal, while at all other parts they were apparently good. Such sheets were, in nearly or quite every case, in fire boxes of engines doing heavy work and having boilers comparatively small for their cylinders and work.

In the case of copper tube sheets this defect seemed greater even than with steel sheets.

The cause of this cutting away of the sheet in the form of a groove around the tube end is due, I suppose, to the particles of coal and cinder drawn toward the tube by the force of the draft, and those striking the outer slope of the bead on the end of the tube, where it projects into the fire box, turn outward or from the tube, striking the sheet and in time cutting a groove or valley around the end of the tube as stated, while the projecting end of the tube itself suffers comparatively little; the action of these particles of coal and cinders, on the sheet around the tube, being the same as that of sand in the sand blast machines for sharpening files. If this theory is correct, then it will be best to have as little projection of the tube end as possible beyond the face of the sheet in the fire box. To countersink the tube hole sufficiently to receive the head or flange on the end of the tube without leaving a sloping projection on its outer edge will add to the life of the sheet.

In the matter of improvements in the design of boilers and in their construction, that is new and valuable, I have little or nothing to offer. What may seem to be new in these latter days is generally found to be some slight change in an old plan or pattern, or something long known to the public presented in a modified form.

The first successful locomotive boilers made were of the tubular pattern, the fire box surrounded by a water space, and we are using the same form to-day, not having found a better one; and, until some new method of generating power is discovered, we may be obliged to continue the use of the present pattern without material alteration. The "Verderber" boiler, without water space around the fire box, tried on several locomotives on one of the Hungarian State Railways, in Europe, several years ago, seems to have been a failure as regards an improvement on the common form of boiler for generating steam.

There may be in the economy of nature such a thing as "thus far shalt thou go and no farther"—for a time at least—and until such time the wisest course will be to endeavor to perfect that which we have. That we have arrived at perfection in the construction of the locomotive boiler no well informed person will, I think, assert, nor that some one form of boiler will answer best for all classes of engines, kinds of fuel and different qualities of water that must be used. The character of the water as regards the impurities held in

solution, the quality of the fuel to be used as regards its evaporative power, the grate area, the quantity of water to be evaporated in a given time, and the class of engine must all be intelligently considered in fixing upon the form and proportions of the boiler in order to give the best results.

In illustration of the fact that the character of the coal to be used should be considered in proportioning the grate area of the fire box, I will give the results of a series of tests made in the boiler of one of the passenger engines running on the Louisville & Nashville Railroad, between Louisville and Nashville, in the months of April and May, 1882, in testing the difference between seven different kinds of coal. The engine had 18 by 24 inch cylinders, 5 feet 3 inch drivers, was an eight-wheeled engine with a boiler 54 inches in diameter, the wagon top raised 6 inches above the cylinder part, and a 30 inch dome. The fire box was 72 inches by 34 inches at the grate, 191 two-inch tubes 11 feet 5½ inches long; the fire box was fitted with the brick arch, supported on four water pipes tapped into the sheet below the boiler tubes and into the crown sheet 13 inches from the back sheet; grate area 12½ feet (live grate), tube surface (inside diameter) 1,052 feet, heating surface of fire box 115 feet, total 1,167 feet (deducting for tube holes, fire door and surface below the grate).

During these tests the engine was run and fired by the same men, the coal carefully weighed and the water accurately measured. The average speed of the train, including stops, was 27 miles per hour, and the average number of cars per train was $6\frac{7}{10}$. The conditions under which the tests were made were as near alike as it was practicable to make them. Wood was used for firing up. The water was gauged when the first coal was put into the fire box previous to starting on each trip.

EVAPORATION OF WATER TO ONE POUND OF COAL.

Coal.	Engine Miles.	Pounds of Water.
No. 1	374	7.311
" 2	561	5.827
" 3	374	6.402
" 4	374	6.269
" 5	374	5.3[illegible]3
" 6	748	5.482
" 7	561	6.327

Average temperature of water in tender, 65° Fahrenheit.
Average steam pressure in boiler, 130 pounds.

The total engine mileage was 3,366 miles, and the average evapotion was 6.002 pounds of water to one pound of coal consumed. ach trip or run was 187 miles.

Coal No. 1 was the best quality of Pittsburgh, No. 2 an inferior uality, No. 3 Alabama coal, No. 4 Tennessee coal from near Chatnooga, Nos. 5, 6 and 7 from mines in Central Kentucky. The fference in evaporation between the best and the poorest of these als was 26 per cent. In other words, the poorest coal (No. 5) aporated 26 per cent. less water to the pound than the best coal Io. 1).

To evaporate the same quantity of water in a given time, 26 per nt. more of the No. 5 coal must be burned than if No. 1 coal were ed; and if the grate area was the correct proportion for burning e best coal, it would be too small for the poorest, and vice versa.

The train average in cars was the same in both cases, and the speed e same, and tests made going the same way (south). The differce in the results, therefore, was due to the difference in the coal. his will serve to show that our monthly reports of coal burned per ile and per car hauled are of no practical value for comparison ccept were the coal is the same in quality.

Comparing the performance of an engine using coal No. 5 with ne using coal No. 1 would be very unfavorable for the former, king quantity only into account. The boiler using that coal ould be considered very inferior, or the one using coal No. 1 be edited with merits not due to it if the quality of coal consumed as not considered, the whole difference being due to the fuel and ot to any difference in the boilers.

As a rule it may be said that the area of "live grate" should be s small as possible that will burn the amount of fuel necessary to enerate the required amount of steam. The area of grate to give he best results will depend largely on the quality of the coal used.

For instance, a grate area of the proportions generally used in he Wooten boiler would certainly be wasteful in fuel where a good uality of bituminous coal was used, but would, perhaps, be the most economical where a very inferior quality of anthracite or semi-bituminous coal is burned.

As nature has made the coals to differ greatly in kind and quality, equal variety in the proportions of grate and to a certain extent of

fire box and boiler seem necessary in order to obtain the best results in its consumption. Careful tests and observations must be relied on mainly to determine the proper modifications necessary to suit each variety of fuel. No one pattern of boiler will answer best for all kinds. It is important, more particularly however where bituminous coal is used that is rich in gas, that the area of fire box be large enough to give time for the perfect combustion of the gases before they enter the tubes; that the heating surface be as great and the boiler as large as possible within the limits allowable for the class of engine in which it is used.

A large quantity of water in the boiler gives a large capacity for storing away heat (power), accumulating it when the demand for steam is comparatively light, and giving it out as required in the variable quantity of steam required in a given time in the ordinary use of the engine, without causing the great variations in boiler pressure that occurs when the boiler is deficient in capacity.

A large boiler, like a fly wheel, accumulates power when it would otherwise in part be wasted and responds to sudden demands for it, for a time at least, without much apparent diminution of its force.

As regards the material for boilers and character of the workmanship there need not be any very great differences, all should be as nearly perfect as possible. A boiler that is strong enough may be said to be as strong as it is worth while to make it, no matter how constructed. But a boiler may be strong enough when new and yet not strong enough to withstand with safety to a good old age the weakening influences of corrosion, unequal expansion, the springing of the sheets from their original shape by pressure and the strains from the boiler attachments.

Theoretically and practically our boilers are ample in strength when new, but in the course of time the influences referred to have in many cases so operated on the boiler that it is found to be in parts both theoretically and practically too weak. Where the metal was three-eighths of an inch or seven-sixteenths of an inch thick originally, it is found to be perhaps less than one-fourth of an inch in places; and at others, where the thickness has decreased but very little, cracks or furrows are more or less developed, caused by expansion and contraction, or other strains that spring the sheet (I

refer to the shell of the boiler and not the fire box), and this too before the boiler has been in service half its natural lifetime.

Patching or replacing these defective sheets then begins, probably, too, at a time when it is most inconvenient to do it.

Testing a large number of boilers by hydraulic pressure that had been in service a number of years, as they came to the shop for repairs, convinces me that the margin of safety between the ordinary pressure carried and that necessary to produce rupture in the weakest place is unpleasantly narrow in the case of many old boilers in service on the roads in this country.

At the base of the dome seems to be the weak point in many old boilers, insufficiently braced, as far as my observation goes. Much improvement has been made of late years in increasing the strength of boilers by the use of thicker sheets, a better plan of joints and seams, and better bracing; but, as a rule, there is still room for improvement in that direction.

Our English friends are far ahead of us in the strength of their boilers. We think they go to the extreme in using butt joints, outside and inside welt pieces, drilling and reaming all rivet holes, and in the thickness of plate used, etc., and, perhaps, to a certain extent they do; yet I am satisfied that if we imitated them a little nearer, in the thickness of plate for the shell of the boiler and strengthening the base of the dome, it would be a paying investment in the matter of durability and lessening the cost of repairs.

As a rule the metal used in the shell of our boilers is not thick enough; not that the boiler is deficient in strength to withstand the steam pressure with perfect safety when new, or that the seams are not strong enough, but there is a want of *stiffness* or *rigidity* about it. In other words, the shell of the boiler is not as strong proportionately as the other parts of the engine, and it is generally the first among the expensive parts to require repairs.

When the diameter of what was considered a large boiler, some years ago, was 44 inches, the thickness of the sheets was seldom or never less then three-eighths of an inch; now, when the common size for a large engine is 54 inches, the thickness is seldom more than seven-sixteenths of an inch. The diameter has been increased 22 per cent. while the thickness of the sheet has only been increased about 16 per cent.

Considering that the steam pressure has also increased with the increase in the diameter of the boiler, to the extent of perhaps 8 per cent., the thickness for the sheets for the shell of a 54 inch boiler should be half an inch to be as strong proportionately as the 44 inch boiler when that was the general size in use.

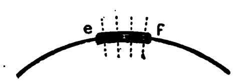
Mr. M. N. Forney, of the Railroad Gazette, has kindly sent me sketches of a plan for strengthening the boiler at the base of the dome, which I present with this paper as worthy of consideration. Mr. Forney says:

"While in England last year I noticed that instead of putting two longitudinal seams on each side of the outside of the fire-box shell, they bring the two side sheets up and make the joint on top. Their method of putting on the dome is different from ours, so I have made the enclosed sketch, showing how their plan of construction could be adopted to our plan of putting on the dome.

"Instead of putting the seams at *C* and *D*, Fig. 1, the two plates are carried up and join each other, end to end, at the top, as shown in Fig. 2, which is a section on the line *A B* of Fig. 3. A thick plate (five-eighths of an inch or three-fourths of an inch) is then made of the form shown in Fig. 4, and forms the welt or covering strip for the seam and also the reinforcing ring for the opening for the dome. This plate may be flanged up as shown and the dome riveted to it as represented. Short covering plates are riveted on the outside as shown at *e f* and *f g* in Fig. 3. The section of the seam is shown in Fig. 2. On the English engines the plate which I have represented on the inside is put on the outside and forms part of the dome base and made of angle or channel iron. Of course the outside plate or ring can be made as thick and wide as may be desirable. This plan, I think, makes a much better job than the ordinary method of construction used in this country. It gets rid entirely of the longitudinal seams, which are liable to crack, and the opening for the dome may thus be reinforced as much as may be desired."

The only objection to this plan of strengthening at the junction of the dome and boiler, it seems to me, would be the difficulty in fitting the ring piece to the dome and the boiler sheets, so as to make a perfect fit. Where so many laps come together, and of the shape shown in the sketch, it is very difficult to draw the laps perfectly tight together, and if the fit is not perfect in all parts, leakage is liable to occur sooner or later at the rivets at such place.

FIG. 2.



Section on ab.

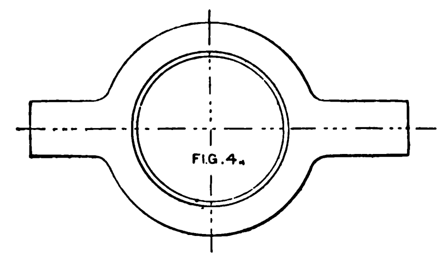


FIG. 4.

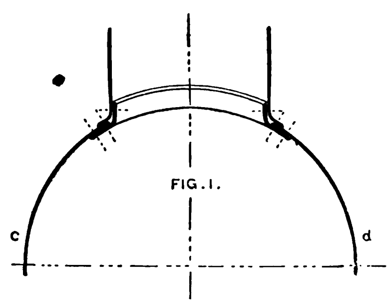


FIG. 1.

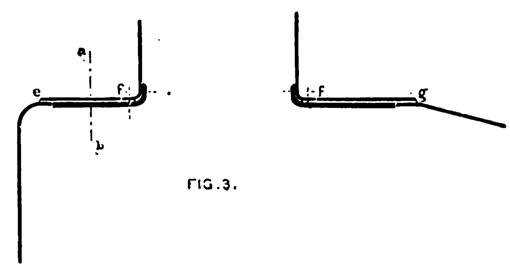


FIG. 3.

being equal. Where bad water is used, the difference between the two plans of boiler, it seems to me, is this: In the one having crown bars the whole of their surface affords area on which the deposits of scale are formed; they are not heating surface, and the deposits on them would do no harm, except that when they became heavy more or less of the scale breaks off and falls on the crown sheet, preventing the water at such places from coming in direct contact with the sheet, and if not promptly removed the sheet becomes overheated and in time "bags" down between the bolts, making a pocket in which additional scale, falling from the crown bars, is held and the evil increased. In the case of the boiler having no crown bars, this source of evil does not exist to so great an extent, and in that particular at least it is the best.

Now if we assume that a crown sheet 72 inches by 46 inches is supported by crown bars, fourteen bars made of two pieces of 5 by $\frac{7}{8}$ iron will be required. These have their outer and inner surfaces in contact with the water. Each bar (pair) has a surface of about one thousand square inches exposed to the deposit of the impurities in the water, in addition to the surface of the sheet itself and that of the braces and stays that may be situated directly over it and below the water line.

In the case of a crown sheet of the above dimensions, stayed by bolts to the outer sheets of the boiler, about 126 bolts 1 inch in diameter would be required. If the depth of water carried over the crown sheet averaged 12 inches, the surface of these bolts, exposed to deposits of scale, would be 4,747 square inches, or only 33 per cent. of the surface presented by crown bars.

From this it is safe to conclude that the crown sheet stayed by bolts to the outer shell, without the use of crown bars, will receive only about one-third as much of this detached scale falling from the surfaces of the bolts and bracing directly over it, as the one supported by crown bars; and as the detached scale falling from the crown bars and braces where the water is very impure is a troublesome and expensive matter, the question of reducing the "dead" surfaces, as they might be called, where these deposits are formed, to the lowest practical point is one, it seems to me, worthy of more consideration than is generally given to it.

R. WELLS.

On motion, the report was received.

THE PRESIDENT—The subject is now open for discussion; it is one that is of the greatest importance to us all. The proper designs of the locomotive boiler is one of the most interesting subjects that we have before us, and I hope the members of the Convention will take occasion to discuss it thoroughly. If any one has any ideas on the subject that are new, let them be made known. To-day we are asked to do with locomotives what we were never asked to do with them before. Instead of car loads of eight or ten tons, we now have car loads of twenty or twenty-five tons, and we are expected to haul about the same number of cars with the increased loads as we did formerly. To do it we are obliged to have a larger locomotive. The question is how to get a locomotive with sufficient steam capacity to perform this increased work. This calls for changes in our boiler construction.

MR. FRY, New York West Shore & Buffalo Railroad—I think the members must find great difficulty in discussing the report, as it refers so constantly to sketches, without having the sketches before them. One of the gentlemen who sat near me has gone out to get a blackboard, and when we have sketches on the board to show the forms of construction referred to it will enable the members to discuss the report more intelligently. One great value that these reports have, of course, is their circulating amongst us and giving us records of what is being done in the country; but it is also, undoubtedly, very interesting to members to know what is thought of the various designs of their fellow craftsmen, and the dominant feeling is that such a report can hardly be discussed at all until we see the various methods of construction referred to. If there is no question before the Convention I would like to move that the discussion be postponed until we have a blackboard, so we can have the means of seeing before us what has been described.

MR. FLYNN, Western & Atlantic Railroad—Would it not be better to read the report of Mr. Johann, and then when we enter into the discussion we will have both papers before us. I offer it as an amendment that the report of Mr. Johann be read.

THE PRESIDENT—The report of Mr. Johann is not in the hands of the Secretary.

MR. FLYNN, Western & Atlantic Railroad—I withdraw my amendment.

Mr. Fry's motion was carried.

THE PRESIDENT—By a vote at a former session, which never has been rescinded, we have set apart the hour between twelve and one o'clock for the general discussion of subjects that may be proposed; and I would suggest that at the present time, it being so near twelve, that we devote an hour to the discussion of subjects that members may present for our consideration. If any have subjects which they would like to present they can now have the opportunity of bringing them forward.

THE SECRETARY—Two subjects have been presented; and in reading these questions I will just remind the members that the rule is that the member

submitting the question shall open the discussion by presenting his views upon it. The first question presented is from Mr. Wilder: "What is the Maximum Limit of Weight to be Allowed per Wheel for Locomotives."

Mr. Fry, New York, Buffalo & West Shore Railroad—Mr. Wilder is not present; but I believe that I can pretty well express his views as he and I have discussed the subject very frequently; and in order to raise a discussion there is nothing like exaggerating one's views, and leaving it for Mr. Wilder to modify what I say in his behalf, I will state that he believes there is a certain weight on the driving wheels, which is occasionally reached in practice, which is so detrimental to the tires of the driving wheels that the engines only have to stand still long enough in order that the tires will be worn out, and that it is an extremely important thing for those designing locomotives, to be aware when that point is reached. I think Mr. Wilder is of the opinion that that point has been reached in practice in America, and that engines now in existence are rapidly wearing out their tires in standing still. This, of course, is a very exaggerated statement of his views; but, undoubtedly, there is a very important principle underlying it. If there is a point at which tires will be very rapidly deteriorated by the weight placed upon them, and inside of that point they will last much longer, it is very important for us to know it. In other words, the question is whether, when we reach the limit of elasticity in the metal, the tires, and of course the rails, do not wear very much more rapidly than when we keep just inside the limit. If I may illustrate the question in another way, there is an impression that a piece of iron may be stretched, may be strained a very great many times, almost up to its elastic limit, without doing it serious injury; but a very few pounds added to the strain applied to the iron will give it a permanent set. The question is then: Is there a certain weight we can place upon our tires which will permit the tires to do good service for a length of time, and is there a very slight addition of weight we can place upon them which will very rapidly wear them out? That is the way I believe in which Mr. Wilder wishes the question to be presented to the meeting. It has been suggested that it would, perhaps, open the discussion more rapidly if we were to ask for information from the members present as to what is the heaviest weight which is known to be placed upon any single pair of drivers; and then, if we can ascertain whether the wear of tires subjected to this heavy weight is abnormally rapid, it would perhaps lead to conclusions which will be of value to us.

Mr. Wilder. New York, Lake Erie & Western Railroad—The maximum weight allowed on the driving wheels of locomotives varies very much upon different roads. Upon our road the limit which our chief engineer almost insisted upon our keeping is 13,000 pounds, 12,000 pounds being the preferable amount. In building our Consolidation engines we have put only 11,000 pounds on a single driver; and if we can be allowed to place, as they are doing now in many instances, as high as 17,000 or 18,000 pounds upon a

Note.—Mr. Wilder here came in and joined in the discussion.—Secretary.

driver, we can build engines to do the work required with a less number of wheels, and it is a point we should ascertain as soon as possible, because in designing new engines for different classes of work coming up, especially these fast passenger trains, we ought to know what the exact limit is.

THE PRESIDENT—This question ought to provoke some discussion. I suppose the practice of the different members varies widely in this matter, some carrying from two to three tons more per wheel than others would think advisable. I would say, for myself, that I have no means at hand to determine the weights carried upon English locomotives per wheel, but I think on some of their engines with single pairs of driving wheels they must get very much more weight than indicated by Mr. Wilder. In fact, I think, it is not unusual at all to get from eight to nine tons per wheel in English practice. Now if eight tons, for instance, can be carried on a wheel safely and without detriment to the wheel, tires or track, it is very important that we should know it. It seems to me that there are some members of this Association who must have had experience that would lead them to have some opinion as to the limit to which we can weight down a driving wheel. I hope the members will be forward in expressing their views on this matter.

Mr. WILDER, New York, Lake Erie & Western Railroad—I meant to say, if I did not, that they are already building engines on different roads, notably on the Reading road, and also on the Pennsylvnnia road, which have eight to eight and a half tons, 16,000 or 17,000 pounds, upon a single driver. Some time ago (probably the members of the Association remember it) a paper was published, by Mr. Chanute, Chief Engineer of the Erie road, upon the foot-plates of a locomotive, in the *National Gazette*, in which he showed diagrams of the spot or point of bearing as taken by putting tissue paper with a little manifold paper under a driving wheel. It showed that the amount of bearing that the driving wheel had upon the rail did not exceed over a tenth of a square inch. That would show that the pressure upon that point, if we had 12,000 pounds on the driving wheel, would be 120,000 pounds. Bessemer steel will take a permanent set at about 150,000 pounds, and with 12,000 pounds on the driving wheel, we would then be within 30,000 pounds of the elastic limit.. Of course, as the metal gave way, the point of bearing would become larger until it arrived at a point at which it would sustain the load, but at the same time it would give the rail a little permanent set (it might be very slight); but by continually increasing that weight we would soon destroy the cohesion of the molecules of the rail and they would peel off. I think you will find that on all driving wheels where we have got over 12,000 pounds we have an excessive wear on tire and rail.

Mr. SEDGLEY, Lake Shore & Michigan Southern Railroad—This is a subject on which we are all interested. I notice that there are several locomotive builders with us and I will call upon them to give us their heaviest weights that they have applied to their driving wheels. I notice a gentle-

man from the Rhode Island Locomotive Works; I would ask him if he can give us some information in regard to this matter. I have always supposed that about 12,000 pounds per wheel was the limit for a road on which the rail did not exceed seventy pounds to the yard. Experience has led me to believe that your road must be very well ballasted and very well tied to exceed that, particularly if you are running fast trains; but I am very anxious to get information on that subject.

Mr. DURGIN, Rhode Island Locomotive Works—I do not know that I can throw any light upon this matter as regards the wear after the engines go on the road; but a few months ago I placed an engine on the New York & New Haven road and it has been in constant use since. I examined it the other day and it did not show excessive wear on the wheels, and they stated that they would not have a pound taken off it under any consideration. Those wheels have eleven tons on each pair, 88,000 pounds on the four wheels. We have been putting out passenger engines, in the last year, running from 58 to 60 and 64,000 pounds. We have one passenger engine running now which is running sixty-two and a half miles in one hour and fifteen mitutes, making one stop, it has 62.000 pounds on the driver, and I can not see any perceptible wear on that more than on the others. Touching Mr. Wilder's remark that the tire has very little bearing on the surface of the rail, when it is first put out, I do not consider that that has much to do with it. I think we should give our tires more bearing when they go into service and not wait for them to wear out before getting it. I believe in giving it to them in the first place and that we will then get better results. It is going to come to it sooner or later and why not give it in the first place? I would have no objection, so far as I am concerned, to going up to 100,000 pounds on four wheels, giving each the proper proportion of bearing. We increase bearings on our journals, why not increase the weight also? Of course there is a limit beyond which you can not go; but we are improving the quality of tires and rails, and I do not see why we should govern our practice as if we were still using iron tires and iron rails.

Mr. WILDER, New York, Lake Erie & Western Railroad—Mr. Durgin says that he believes in getting more bearing upon the rail. My idea is that the point of contact of a cylinder (which is what a perfect wheel is) upon a plane (which our rail certainly is) would give nothing but a line, that is if they just come together; but if there is any more bearing than that it must be got by the elasticity of the two metals. You can not make a cylinder or a circle touch a plane and give any thing but a point—a sphere will make a point and a cylinder a line, depending on the length of the cylinder—and how you are going to get a greater bearing unless you have flat spots on your tire I can not perceive with the track that those wheels made on thin tissue paper, showing that the whole ground of the area carefully measured would not average over a tenth of a square inch. Now as to

how you are going to get a greater bearing than that I would like to know. If Mr. Durgin can explain that, it may be of great advantage to us.

Mr. DURGIN, Rhode Island Locomotive Works—I understood that it was results that you were asking for, and I endeavored to give them.

Mr. WILDER, New York, Lake Erie & Western Railroad—The practice of putting great weight on our driving wheels has come up within the last few years. Our practice, up to within the last three years, has been to keep within the limit of 12 000 pounds; and having been educated to believe that that is all we want to put upon a single driving wheel, it is a little startling to me to find that they are putting on, and, in the particular case of a locomotive which I understand Mr. Wooten designed, have put on 19,000 pounds.

Mr. FRY, New York, West Shore & Buffalo Railroad—It seems to me rather interesting to note that with the growth of these weights on the driving wheels there has also a very marked change taken place in results in railroad practice, that is, the extraordinary decrease in the cost of transportation. For a long time it was customary among our best railroad managers to treat locomotives as though they were meant to be put under glass cases and to treat rails as though they were made of gold, a material which some one once told the B. & O. people that they could afford to make their rails of. Locomotives were always under the care of one man, never ran too far at a time, and were always kept in the house for fear they would take cold, so our cost of transportation was very high. During the last few years it has been the practice to run the locomotives under the care of anybody who could be found to run them; they have been made to pull the heaviest trains possible, and they have not been provided with many extra accommodations or had extra care; it has been urged that as they are made to run in storms they might as well stand in the storms the few minutes they have to wait for other trains and other drivers to get aboard them; heavier trains have been hauled and with this has come the practice of crowding weight on the driving wheels. If it causes the wheels to wear faster, it has taken us a long time to find it out; and the decrease in engineers' and trainmen's wages has more than counterbalanced the extra wear of our rails and tires. Without asserting that the decrease in the cost of transportation is due to this it is rather interesting to note that they have come about at the same time. Showing what is being done, I have just jotted down from the information which has just been given here, and from conversations with gentlemen I have met at this Convention, some weights which are in actual practice to-day: On the Erie Railroad, on a pair of wheels, 26,000 pounds; on the Pennsylvania Railroad, on a pair of wheels, 32,500 pounds; on the Central Railroad of New Jersey, on a pair of wheels, 31,500 pounds; on the Reading Railroad, on a pair of wheels, 34,000 pounds; on one of the English railroads, the Great Northern I believe, 40,320 pounds; on the engine mentioned by Mr. Durgin, 44,000 pounds. Now it will be, of course, very inter-

esting to know how fast the tires wear with these excessive loads. The wear of the tires must be very rapid to more than compensate for the saving of trainmen's wages.

Mr. Wilder, New York, Lake Erie & Western Railroad—Mr. Fry's remarks would convey the impression that the diminished cost of transportation was in some way connected with the increase of weight on the driving wheels. The maximum weight on the drivers on our road is, as Mr. Fry has stated, 26,000 pounds. I do not think that a more remarkable showing of the decrease of the cost of handling freight can be shown than by one of the tables of the annual report of the Erie road, which unfortunately I have not with me. As I remember, sixteen years ago, the amount we received per ton per mile was two and a half cents or about that, the cost of handling was one and a half cents or very near it. Last year the amount received per ton per mile was eight-tenths of one cent and the cost was about five-tenths, showing a decrease of 66 per cent. in the cost in sixteen years. We have not increased the weight on any single point on our driving wheels, but we have put into service the Consolidation type of engine, putting on more drivers to keep the weight per wheel down to our limit.

Mr. Woodcock, Central Railroad of New Jersey—Mr. Fry referred to our road as having considerable weight on our driving wheels. I will say that one of those engines has run for a little over a year and I have not noticed anything in the way of unusual wear about the tires. I think the quality of the tire has a good deal to do with the wear. I have noticed in some of our lighter engines that they some times have more wear than those referred to as having the excessive weight.

Mr. Durgin, Rhode Island Locomotive Works--I wish to state that it is on a double-end switch engine, used on the New York and New Haven road, at the Harlem river, where there are 88,000 pounds on four wheels.

The President—What is the weight of your road engines?

Mr. Durgin, Rhode Island Locomotive Works—64.000 pounds is the highest of any we have got; they vary between 58,000, 60,000 and 61,000 pounds.

The President—There is another item that has been touched upon in this discussion that interests me, and that is the tendency to decrease the cost of moving freight, where it can be moved in large quantities, with fewer engines. Now I believe that every man here, who has had anything to do with what is known as through freights, will say that his experience has convinced him that big engines and big trains are an important factor in reducing the cost of transportation. The wages of conductors, brakemen, firemen and engineers and wipers might be included also, and perhaps others, as being among the items where there is a saving; and there is another large item, that is the matter of fuel. I think that any one who has made a careful experiment will bear me out in the statement that a large engine burns no more, or very little more, working to her full capacity, than a small engine working to her full capacity.

I would like to get the experience of some of our members on that question. My own experience is that a small engine having heating surfaces in proportion to the cylinder, working at her full capacity, will consume very nearly if not quite as much fuel as a large engine working to her full capacity. If any member has made any experiments to determine that point I would like to hear from him.

Mr. FRY, New York, West Shore & Buffalo Railroad—Confining ourselves to the question of tires more closely for the time, Mr. President, the large engines, as pointed out by Mr. Wilder, are not excessive in their weight on the tires—their weight can be distributed over four or five pairs of tires. I believe in some cases six pairs have been placed on very heavy engines. It is when heavy passenger service has to be done at a high rate of speed that it becomes important to know how far we can go in putting weight on a pair of wheels. Very few of us would like to run our Consolidation engines at a mile a minute, and yet it becomes necessary to haul passenger trains at that rate of speed; and if a large passenger train has to be hauled and is divided into two, of course the cost of hauling those passengers is doubled. Just as we have been consolidating our freight trains, so the tendency is now on our passenger roads to consolidate passenger trains. It is interesting to note that with the exception of the switching engine spoken of by Mr. Durgin the other engines that were mentioned by him as having heavy weights upon their wheels were all passenger engines. A few years ago if we wanted to run trains at that speed, we had to run them in two or three sections where we now put them in one. A gentleman, who will present a paper to us before we break up, Mr. Joy, of England, in showing me a number of drawings that he had with him showed me a pair of passenger engines with a cylinder 20 by 26 inches in size. I am not sure that those engines have been built yet, but it shows what locomotive men are called upon to do.

Mr. WILDER, New York, Lake Erie & Western Railroad—In regard to the matter of heavy engines for passenger service, I met with a problem very similar to that with our trains on the Eastern Division; our grades run there as high as 60 feet to the mile and some times 45 feet for twenty miles at a stretch. We have a train on that division which would ordinarily require from twelve to sixteen cars. In the summer it runs with sixteen cars, in the winter not so many. We are running that train in two sections, with a speed including stops of about 35 miles an hour. I designed a passenger engine for that service, a Mogul having a 20 by 24 inch cylinder and a five-foot wheel, and in that case I found I could not keep within the limit even with the Mogul engine, giving the necessary adhesion and also heating surface. I got the engine so it weighs 13,000 pounds on a wheel, which is above our limit. It is a Mogul engine with a five-foot wheel—we make the time, with sixteen cars, very nicely. As far as this discussion is concerned, I have not as yet received the information I was looking for in asking this question, and

I think the subject is of sufficient importance to make it one to be presented to a committee of investigation to be reported on next year.

Mr. WOODCOCK, Central Railroad of New Jersey—I move it be referred to the Committee on Subjects.

Agreed to.

THE PRESIDENT—There is another question in the hands of the Secretary, who will read it.

THE SECRETARY—The question is submitted by Mr. Woodcock, "In what part of a Locomotive Boiler should Checks be placed, either for Pumps or Injectors, to produce the best results?"

Mr. WOODCOCK, Central Railroad of New Jersey—I believe in uniformity as far as we can reach it. Every one of us must have noticed the difference in the positions in which the checks are placed on our boilers. I ask this question merely to get at the point where we can get the best results from those who have had experience in this line. Our injector men tell us to make the branch pipes as short as we can—some of them at least. Now, if we can get as good results from placing the checks further back from the fire box, I think we ought to adopt that; by so doing that would shorten the pipes that much. Our old plan has been to place check forward in the first course. I find now they are placing some in the centre, some on the first sheet next to the slope, some on the leg of the fire box and other parts. I have lately placed the checks for the injectors on the second sheet, or sheet next to the slope sheet, and I see no serious results from that. What I would like to get at now is the experience of members present, whether they have changed the position of the checks from the usual practice, and if so, where shall we put the check to get the best results.

THE PRESIDENT—Gentlemen, what have you to say on this question? I think that at former conventions, if my memory serves me right, we had some discussion on this subject, and that some members expressed themselves in favor of introducing water into the boiler leg at the rear of the boiler, preferably under the furnace door or in that locality. Others strenuously objected to putting the water in there on account of it producing a supposed unequal expansion. The water coming from the injector goes into the boiler hot; it is immediately diffused in the leg of the boiler, and I very much doubt whether that water produces any injurious or unequal expansion and contraction. I would like to ask if there is any member who has had experience with putting water into the leg of the boiler from the injector, and if so, if he has met with any injurious results. I can say that I see one objection, which I think would be a very serious one on a great many of our Western roads where they have lime or hard water. In introducing water any where near the fire box it is a fact that the greatest amount of *lime deposit*, not deposit from the impurities in the water—floating impurities—is about the entrance of the water into the boiler where it first strikes the hot water and is heated up to a point where it precipitates the lime. That

lime will adhere to anything it touches; consequently the greatest deposit is found where the water is introduced. If that is the case it would be probably bad practice to introduce water near the furnace. I hope that members will give their views on this question, because I think it is one of importance. If it is better to introduce the water forward, it is well to know it; but if it is no advantage, we can by putting it back save pipes from breaking in consequence of their vibration. If you attempt to fasten them the joints will be weakened on account of the expansion and contraction. In fact it is almost impossible to fasten them so that they will not give trouble, and it would be better to shorten the pipe if it can be done with safety.

Mr. FRY, New York, West Shore & Buffalo Railroad—I believe there are two reasons for putting the water in at the front end of the boiler that have weight with our locomotive designers. It is evidently more convenient to put it in to the front end when we have pumps; but, in addition to that, it is considerably better to put cold water in at that portion of the boiler where the heating surface is coldest, so that the differences in temperature might be less, and the best effects in radiation might be produced. I am under the impression that that has had great weight with those who have considered it the best place to put the check. When I was last in England an American Master Mechanic, Mr. Wursdell, the Superintendent of the works at Crew, called my attention to a method of putting the water into the boiler with the injector, which does away with the long copper pipes which our President has referred to, and which obviates the making of a hole in the front end of the boiler, which Mr. Forney has called our attention to as being a very bad practice, and at the same time delivers the water immediately into the fire box, but carries a pipe over the crown sheet and delivers the water about where we deliver it now. It was, of course, a very cheap arrangement, and which kept the pipe out of sight and so abolished one of the objectionable features of our locomotives. I do n't know wether that practice has ever been copied in this country or not, but I think that Mr. Forney also called attention to it when he was visiting the Crew works last year.

Mr. HAYES, Illinois Central Railroad—I would state that in 1852 I built a number of engines and introduced the water at the back end of the boiler, with the pipe running inside, similar to what Mr. Fry has mentioned, but unfortunately I found that the pipes soon became filled up with deposit and were forced off at the sheet, and when I came to bring the engines into the shop to examine them to see how it was working, I found the pipe lying down in the bottom of the boiler, and we had to abandon the practice and run the pipes forward on the outside; and I think you will find that that will always be the result if you use water strongly impregnated with lime. I know that it would be impossible for us to use it out West. I would also state in regard to introducing the water near the fire that in 1870 we put up a stationary engine at Waterloo, in Iowa. I sent a young man there to place the boiler and engine, and he used a wooden pump for injecting the water,

but it was taken from the heater and the water was heated up to about 200 degrees before we injected it into the boiler. It was a new steel boiler, and we put the check right over the fire, and the boiler lasted about two weeks, when the sheet directly under the point of introduction of the water cracked some two or three feet in length. When it came to my knowledge I went there and saw how it happened at once; I had the check removed and a patch put upon the boiler, and it is running to-day and has never given any more trouble. I am satisfied if we went back to the pump, and used cold water, that it would be a matter of impossibility to keep our boilers in order and inject water through the fire box.

THE PRESIDENT—If there is no further discussion on this subject I will take the opportunity to announce the committees which have been ordered:

On Finance—George Richards, William Woodcock, M Pendleton

Auditing—J. M. Boon, F. W. Dean, H. L. Leach.

It will be necessary for us to have a Committee on Correspondence.

Mr. WOODCOCK, Central Railroad of New Jersey—I move that a Committee on Correspondence be appointed by the Chair.

Motion carried.

THE PRESIDENT—The Committee will consist of the following gentlemen: J. H. Flynn, R. H. Briggs, T. B. Twombly. Now, gentlemen, the discussion of the first paper read, Mr. Well's report on boiler construction, is in order.

Mr. FRY, New York, West Shore & Buffalo Railroad—I propose that one of the members of the Committee be requested to make some rough sketches, which would illustrate the forms of construction referred to. I understand that Mr. Pitkin, a draughtsman, is present in the room and would be very willing to make the drawings if the Committee would ask him.

Mr. Pitkin then made the necessary sketches.

THE PRESIDENT—For the purpose of provoking discussion I would like to criticise that method of boiler construction. I am not quite satisfied that the butt joint, so called, with double welts, one outside and one inside, is the strongest possible seam that can be made. Of course it has its advantages when the pressure is on it; but I do not think that a boiler constructed with joints made in that way is as strong as it can be made by other methods. I think a single lap, or a lap wide enough to take two rows of riveting, with that welt underneath extending out to take a row of rivets outside of the same rivets, makes a stronger joint than that method, for this reason: With the method illustrated on the blackboard there are four rows of rivets, and the two outside rows have necessarily got to be close enough together to make tight work, perhaps two inches from centre to centre. If they were wider than that there would be great liability of leaks occurring. Now a seam with rivets only two inches or two and one-eighth inches from centre to

centre reduces the strength of the sheet very materially. By making a single lap or double lap, if extra strength is wanted, the rivets passing through the lap can be placed close enough together to make tight work; then the seam is re-enforced by the welt underneath, and the rivets through the edge of the welt can be placed at least three inches apart, because they have nothing to do but fasten this welt to the plate to re-enforce it where it is liable to cut away by the steam. It has nothing to do with making tight work. For that reason I claim that a double-riveted seam, with a single welt underneath, having a row of rivets at each edge, is stronger than the method illustrated on the blackboard.

Mr. FRY, New York, West Shore & Buffalo Railroad—A great deal of very valuable information ought to be obtainable from this Convention on this very subject. The reason for making a butt joint, as given to me by those who use butt joints, has always been that it prevents the furrowing at the seam, which is common with the ordinary lap-edged boiler where the water is bad. The Rogers firm in Paterson have used the seam referred to by our President, and they have found it cheaper than the joint illustrated there; and if it obviates the furrowing of the seam it would be extremely important if any of the members who have been building boilers in that way could give us information as to whether the furrowing action is prevented by that inside welt. The double-riveted ordinary lap joint is amply sufficient for our boilers so far as mere strength is concerned; and I believe it is simply a question of prevention of furrowing that has led to the butt-jointed boiler.

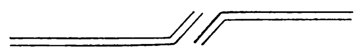
Mr. WILDER, New York, Lake Erie & Western Railroad—I would ask Mr. Fry why the joint of the lap would make any difference with the furrowing of the boiler. Take a single lap joint with a double row of rivets, would not the action be the same where those two came together as it would be where you put a welt on? I can not see how it makes any difference if the rivets hold the welt down tight to the sheet. The only thing I can see is that by putting on the welt you are more liable to get the full tensile strength of the metal that is lost by reducing the area of the sheet, as we do in a single row. We make the lap with one regular row of rivets, and then put the welt on, taking off part of the strain.

Mr. FRY, New York, West Shore & Buffalo Railroad—In reply to Mr. Wilder I would say that I really do not know why the butt-jointed boiler should not furrow; I have heard those who have given the matter attention state several different reasons. I was assured when I last visited England that since they adopted the butt joint, which is a method of construction taken up since the time I was there, they have to a large extent prevented that furrowing action. I believe one of the principal reasons that induced Mr. Johann to adopt that form of joint was to find a method of preventing that furrowing action. Now if the furrowing is prevented by the butt joint, it is, of course, a very valuable thing; but if we can prevent the furrowing action just as well by the joint suggested by the President, it would, perhaps,

be just as well. Without putting forward any theory, or accounting for the result, I would merely say that those joints are suggested because they have been found in practice to obviate that furrowing action.

Mr. WILDER, New York, Lake Erie & Western Railroad—I suppose it is generally admitted that there is no furrowing action above the water line; and the only object I can see of the lap welt is to give additional strength to the joint.

THE PRESIDENT—I suppose, gentlemen, that it is well known what produces this furrowing effect. When a lap is made in the usual way it is like



that [illustrating]. You put that under strain and it will assume the form of a circle. That may be slightly exaggerated; but everybody knows that when a boiler is put under strain that those two plates will not draw on the same line; consequently it will bend that plate there and cause a disturbance in the fibers of the iron [indicating], and the consequence is that a raw spot is made and at last a furrow is cut directly through the plate; that, I think, is undoubtedly the cause of so much furrowing. Mr. Sedgley has had some experience in butt and welt joints, and I should like to hear from him in the matter; I would say though that I know but very little about the trouble that other people profess to have in the action of scales upon their boilers Upon our road we have what we call good water, and have very little trouble in that direction.

Mr. SEDGLEY, Lake Shore & Michigan Southern Railway—We never have put into practice the butt joint. We have engines, however, upon our line in which our boilers have been used for twenty-five years with the welted joint. The welts were made from five-sixteenths inch iron; and during that time they have been constantly in hard service, and to my knowledge we have never had to repair a boiler where the seam was welted. We have on portions of our line very bad water; and the same class of boilers without the welt will require patching inside of four years on account of furrowing completely through the sheet. We have had some very severe cases of furrowing below the water line, but no trouble above the water line. I have had five-sixteenths inch plates furrow through inside of eighteen months so there would not be a sixteenth of an inch left. I had one case where we discovered a leak in the bottom part of the boiler, and we were obliged to take out the tubes to ascertain the cause of it, and we found at least sixty inches of the longitudinal seams that would not measure one-sixteenth of an inch in thickness. I think if we will put our seams at the top of the boiler instead of the bottom we will, to a large extent, obviate the trouble we have in furrowing.

Mr. DURGIN, Providence Locomotive Works—I understand that Mr.

Sedgley recommends the welting of the circular seams, and I would also like to ask him if those circular seams in the boilers to which he refers were single or double riveted?

Mr. SEDGLEY, Lake Shore & Michigan Southern Railroad—Both single and double. It makes no difference about the furrowing.

Mr. WILDER, New York, Lake Erie & Western Railroad—If Mr. Durgin will allow me to correct him—I do not understand Mr. Sedgley to say that he also welts the circular as well as the longitudinal seams.

Mr. DURGIN, Providence Locomotive Works—I would ask Mr. Sedgley whether it is the lap or the butt joint to which he refers?

Mr. SEDGLEY, Lake Shore & Michigan Southern Railroad—The lap is the one I referred to as being only one-sixteenth of an inch thick. I think it was a case where the circle was not uniform, and there was an unusual amount of strain when the boiler was under pressure, so that the grain of the iron was exposed upon the inside; and I look upon it as a sure cure for that trouble to welt the seam.

THE PRESIDENT—Before Mr. Sedgley sits down I would like to ask him what thickness of welt he would recommend for a three-eighths inch shell?

Mr. SEDGLEY, Lake Shore & Michigan Southern Railroad—We would use five-sixteenths for a three-eighths inch shell. I presume that a quarter inch would be sufficient to protect the seam.

Mr. WILDER, New York, Lake Erie & Western Railroad—Mr. Sedgley's remarks would seem to bear out the statement I made that little or no furrowing takes place in the boiler above the water line. If we need the welt to strengthen the joints it is all right; but if we order our sheet large enough across, all seams can be placed above the water line, and we shall not require welt joint for a protection from furrowing.

THE PRESIDENT—I presume there are gentlemen who have had large experience and a great deal of trouble with the furrowing of the circular seams as well as the longitudinal. I presume nearly every one has corrected the evil of the furrowing of his longitudinal seams by making the shell of one or at most two sheets, and carrying the seams above the water line. That is probably the universal practice. In that case the welt upon the inside would simply need to be used to re-enforce the seam where it was cut away by the rivets. I understand Mr. Hayes has had a great deal of trouble with the furrowing of his circular seams and has devised means to correct the difficulty. The Convention would like to hear from him in regard to it.

Mr. HAYES, Illinois Central Railroad—For the last ten years we have built all of our boilers in one or two single sheets for the cylindrical part of the boiler, making all the longitudinal laps on the boiler above the water line, and in no case have we had any trouble with the furrowing of the seams; but in the older boilers as built some twenty years ago, where the seams were below the water line, we had a great deal of trouble in the fur-

rowing of seams; but after having a good deal of trouble and patching in various ways, we put a liner of three-sixteenths inch iron running around about one-third of the circle of the boiler, riveting very lightly, and in that case we found an entire prevention of the furrowing of seams. I think we have had it in use four or five years The first was put on an old boiler that had furrowed until it became weak—we put it in there merely as a strengthening sheet; but when we examined it we found that the furrowing did not continue although we used it two or three years after, and since then we have adopted it on all our new boilers. We put this liner inside, running around one-third of the circle of the boiler, and in no case have we had a single seam to furrow since we adopted that system.

Mr. Wilder, New York, Lake Erie & Western Railroad—I would ask Mr. Hayes if in every case he had perfectly steam-tight joint for the liner?

Mr. Hayes, Illinois Central Railroad—In answer to Mr. Wilder I would state that we put the rivets about five inches apart, and the water passes between them until it forms a scale and is water tight. That scale or glazing seems to remain, but it does not cause any furrowing at all.

Mr. Durgin, Rhode Island Locomotive Works—How wide is this liner? How far from the edge of the lap do you extend it?

Mr. Hayes, Illinois Central Railroad—The whole length of the boiler, running around one-third of the circle.

Mr. Durgin, Rhode Island Locomotive Works—Then you rivet on the longitudinal part simply?

Mr. Hayes, Illinois Central Railroad—Yes; it just rests on the top of the rivet heads.

The President—The experience of Mr. Hayes somewhat upsets my theory, it seems to me. I was going on the theory that the furrowing was entirely due to the bending action of the plate that takes place when put under pressure, and then comes back when the pressure is taken off. This liner certainly does not reenforce those seams. They are subject to precisely the same pressure, and must assume the same form they would if the liner was not there. I am afraid we are attributing the furrowing to causes that are fallacious. If putting in a liner from one-eighth to one-sixteenth of an inch will settle it, it can not be due to the fact to which I have attributed it.

Mr. Hayes, Illinois Central Railroad—We have the same mechanical action in the seams above the water, but we do not have the furrowing. That occurs only in seams below the water line, and hence it is the chemical action that goes on during these different strains, and by putting in a liner you prevent that chemical action. You have the same mechanical action as you had before; but in no case do you find the seams to furrow when they are above the water line, consequently the chemical action is entirely below the water line, and this liner being below the water line prevents that entirely.

The President—I fail to see clearly to my own satisfaction why the chemical action spoken of does not take place as well with a liner there as

without it—of course I thoroughly credit the preceding speaker in regard to the cause of this. It is the mechanical action and the chemical action combined. Either one by itself would not do it; but the mechanical action disturbs the vibrations there and keeps the place raw. If they get glazed over a little the first time you heat them up, it leaves the raw iron; and the moment you get a furrow started there is a weak spot, and all the strains are concentrated there, and that place keeps raw. But how the mere fact of laying a piece of iron in the bottom of the boiler, resting on the rivet heads, perhaps leaving half an inch space between the two, and putting in a few rivets to keep it in place, prevents this supposed chemical action I fail to see.

Mr. WILDER, New York, Lake Erie & Western Railroad—As Mr Hayes explained in answer to a question I put in regard to that, the space between the plate and the rest of the boiler was filled up with mud and other deposits from the water. That space having once been filled excluded further action of the chemical properties of other substances deposited on the plate, and the plate itself keeps the chemical action of the fresh deposits from acting upon the seam. There is no doubt at all that until that space is filled there is a chemical action, and the furrowing goes on as the result of the oxydation of the iron, as the place is kept raw.

Mr. DURGIN, Rhode Island Locomotive Works—What prevents this grooving of the liner? I understand that it does not groove on the liner at all.

THE PRESIDENT—Simply because there is no pressure, no strain upon it. It gets pressure on both sides.

Mr. DURGIN, Rhode Island Locomotive Works—There is certainly a strain on it if it is riveted.

Mr. WILDER, New York, Lake Erie & Western Railroad—There is no lap there at all.

Mr. HAYES, Illinois Central Railroad—It is simply a liner made one-third of the circle of the boiler, bound to the same circle, and there is but one seam that it has to pass over. We curve it so as to get it down somewhere near to the bend of the boiler, and simply put a few rivets in it to hold it there. The rivets are about five inches apart—simply to hold it in place.

Mr. FRY, New York, West Shore & Buffalo Railroad—I would like to ask whether grooving takes place if the lap is only a short distance below the surface of the water? We have learned from the present discussion that no grooving takes place if the lap joint is made with a covering strip over it, and that even a very light liner will prevent grooving. Now it sometimes happens, in designing a boiler, that it is difficult to get the lap entirely out of the water space; and there are quite a number of boilers running with the laps in that space. I have been informed that they do not groove when they are just a little below the surface. If we can get information in regard to that it will be very useful. This is almost an interminable subject, but if we can collect all the facts about it they will be very valuable to us.

Mr. SETCHEL, Kentucky Central Railroad—I am not so sure that that

seam, being reenforced by the lap, is not the cause of preventing the grooving. You put a lap over the seams of four or five-sixteenths thick, as Mr. Hayes suggests, and that reenforces the seams, so that the tendency of two sheets riveted together to draw exactly into a circle is prevented. If you cut your finger and leave the cut open, and keep working it, the cut will keep working down; but you put a piece of plaster on top, to keep those edges together, and the wound will heal; and so the effort of the plates to draw into line moves the fibers of the iron, that throws off the scale and it is attacked by every fresh quantity of water that comes in contact with it until it works through the sheet, but by the additional strength of this welt-joint that opening and closing process is prevented, and the necessary strength is given to the seams to resist the tendency to draw into an exact circle.

Mr. FRY, New York, West Shore & Buffalo Railroad—Mr. Hayes' method of preventing the grooving does not add to the strength because he fastens the liner down so lightly. The only objection to Mr. Hayes' plan, even if successful, is, to my mind, that it would prevent an examination of one of the most important parts of the boiler to be examined. If I understand Mr. Hayes right, he puts a sheet right down, which does not add to the strength but simply prevents the water from touching the joint.

Mr. WOODCOCK, Central Railroad of New Jersey—I think we have determined from this that the welting of the seams prevents the grooving. If such is the case, why not put a lap or welt strip around the circular seam to prevent grooving there? I should think favorably of doing that.

Mr. WILDER, New York, Lake Erie & Western Railroad—In regard to that, I do not think that a circular welt is at all necessary to strengthen the circular seams of the boiler, because the strains upon those seams are never excessive; and if we can do it, as Mr. Hayes does it, by laying a sheet at the bottom of the boiler, fitting down as close as possible, with a few rivets to keep it in place, I think that is all that is necessary to do, and it is a good deal cheaper.

Mr. WOODCOCK, Central Railroad of New Jersey—I said that in answer to Mr. Fry's objection that we can not examine the boiler with welts over the longitudinal seams. By putting the welt strip around the circular seams we prevent this corrosion or furrowing, which does away with the necessity of examining the boiler.

Mr. DURGIN, Rhode Island Locomotive Works—I have recently put on the road ten engines, with a new kind of a joint or seam in the boiler, which, in a year or two from now, probably, I shall be able to give some information about. I have double riveted and extended the lap of the inside sheet itself six inches—I have done that to resist the expansion and contraction of the seams. Instead of double riveting three and a half or four inches, I extended the inside sheet where the water space comes and do what boiler makers call "stitching around."

Mr. BLACKALL, Delaware & Hudson Canal Co.—I would like to ask Mr.

Hayes if he ever had occasion to remove the welt joint, and, if so, in what condition he found the seams?

Mr. HAYES, Illinois Central Railroad—In answer to that question I would state that we have removed a number of them, but we had no particular occasion to examine them any further than to examine and see how well it had worked, and in no single case did we find any of this pitting or furrowing below the water liner; but we do find that some little pitting takes place in the liner. Now I found before we commenced using them that we were not troubled solely with the furrowing, but we were also troubled with the pitting between the seams. In some places it would eat out the size of a nickel, and half way through the sheet, but by the introduction of this liner we have prevented that entirely; but it does take place a little upon the liner. While I am up, I would add that some of these gentlemen have understood that I put in five-sixteenths liner, I meant to say three sixteenths, that is the size we use. We have not had any occasion to renew any of them since we first introduced them; but while, of course, they will eventually pit so that they will have to be removed and new ones put in, they preserve the boilers so far as our experience has gone (that is nearly five years now) from pitting and furrowing.

Mr. WILDER, New York, Lake Erie & Western Railroad—Do I understand from Mr. Hayes that he would feel perfectly safe to let the boiler go without any particular inspection under the protecting sheet?

Mr. HAYES, Illinois Central Railroad—Of course, in answer to that question, I would say that it requires time to determine that; but so far as we have gone I have found no pitting nor furrowing to occur under that sheet. When we have occasion to renew the flues or the furnace, we propose to take them out and examine them; but, from the experience we have had so far, I think it would be perfectly safe to run five or ten years.

Mr. DURGIN, Rhode Island Locomotive Works—I do not know whether I have got Mr. Hayes' idea or not. We will suppose that that (illustrating) is the bottom part of the boiler; now I understand Mr. Hayes that he puts a sheet right butt up against that (end of boiler).

THE PRESIDENT—He simply takes a plate the length of his rolls and bends it into that form, and lays it in the bottom of the shell of his boiler and puts in rivets five inches apart.

The Convention then adjourned.

SECOND DAY'S PROCEEDINGS.

The Convention was called to order at 9:30 A. M.

The Committee on Finance submitted a report recommending an assessment of five dollars to defray the expenses of the present year.

On motion the report was received, and its recommendation adopted.

The Auditing Committee presented the following report, which, on motion, was received:

Report of Auditing Committee.

To the American Railway Master Mechanics' Association:

GENTLEMEN—Your Committee, appointed to audit the Secretary's and Treasurer's books, beg leave to report that they have attended to that duty and find them correct.

JAMES M. BOON,
H. L. LEACH, } *Committee.*
F. W. DEAN,

The following paper, by Mr. Johann, on "Experiments with a Baldwin Consolidation Engine having the Wooten Fire Box," was presented and read by the Secretary:

Experiments made with a Baldwin Consolidation Engine having the Wooten Fire Box.

To the American Railway Master Mechanics' Association:

MR. PRESIDENT AND GENTLEMEN—The year that has just passed has been such a busy one for me, and has added such an increase to my duties, that I have been totally unable to give my attention to the making of any experiments or locomotive tests whatsoever; but in order to add my quota toward keeping the subject before the Association, I propose to give you a short account of my experience with a Baldwin Consolidation engine having the Wooten fire box, in the burning of Illinois bituminous coal.

This engine was put to work on the Illinois Division of the Wabash Railway, in the latter part of the year 1880, and in December of that year and January of 1881 I made a short series of experiments with it, the results of which I propose to give you with

the hope that they may prove of value to some of the members present and not be lacking in interest to others.

This engine was originally built for the Reading road by the Baldwin Locomotive Works, but for some reasons remained on the hands of the Baldwin people, from whom it was purchased by our company.

It has 20 inch by 24 inch cylinders and possesses the regular Wooten fire box, the dimensions of which are as follows: Length 10 feet, width 8 feet inside, with a combustion chamber 4 feet in length.

As this engine came fitted up with stationary water grates, for burning anthracite coal slack, I deemed it a fine opportunity to ascertain, by actual experiment, whether any success could be met with in burning Illinois bituminous lump coal before making any change in the grate arrangement.

For this purpose I fitted the engine up with an arrangement for registering the amount of water used, similar to the ones previously explained to the Association in other experiments that I have made, but unfortunately the temperature fell to the lowest point of the year during the first trip, and the formation of ice in the apparatus nullified its use, so that it had to be abandoned.

I was, therefore, unable to ascertain the amount of water evaporated per pound of coal used, and can only furnish you the pounds of coal consumed per loaded car mile, of which a careful record was kept.

In making the experiment I had the engine make two round trips between Sprinfield and Danville, a distance of 113 miles, and two round trips between Decatur and Danville, a distance of 74 miles, and will give you, in as few words as possible, a summary of the results obtained:

Performance of a Baldwin 20 inch by 24 inch cylinder Consolidation engine, with Wooten fire-box, in making two round trips between Springfield and Danville and two round trips between Decatur and Danville, on December 28th, 30th, 31st, 1880, and January 1st, 4th, 6th, 7th, 8th, 1881. State of the weather stormy and cold with snow, and thermometer ranging from 20 degrees above to 18 below zero. Ruling grade 40 feet per mile each way:

Total miles run by engine	752 miles.
Coal consumed	170,000 lbs.

Loaded car mileage	27,433 miles.
Empty car mileage	3,803 miles.
Total loaded car mileage (rating five empties as three loads)	29,716 miles.
Average train (loaded and empty)	41.5 cars.
Average train (estimated loaded)	38.2 cars.
Miles run to one ton coal	8.85 miles.
Pounds of coal per loaded car mile	5.7 lbs.

As you will observe the pounds of coal consumed per loaded car mile is exceedingly heavy, but when we take into consideration the heavy snows and stormy condition of the atmosphere, it compares very favorably with the general average of our other engines, most of which are of the regular 16 inch by 24 inch eight-wheel type, as the following table will show:

Pounds of coal consumed per loaded freight car mile during the following years and months:

1879	January	4.21 lbs.
	December	3.92 lbs.
1880	January	3.24 lbs.
	December	5.70 lbs.
1881	January	5.20 lbs.
	December	5.30 lbs.

As a result of the foregoing experiment I found that no difficulty was experienced in burning the Illinois bituminous coal in this class of engine, with stationary grates, when fired in the usual way, one fireman being able to manage the fire while running with as much ease and freedom as he could on any of our other engines; the boiler making steam freely and in abundant quantity to do all the work required.

The chief difficulty we experienced in managing the fire was due to the necessity of drawing the clinkers from the coal through the fire doors when cleaning the fire, which had to be done every 30 or 40 miles while running and at the terminus of each trip. This difficulty, however, is due to the use of stationary grates and could easily be remedied.

As to the capacity of the engine, we found that coming west from Danville 60 loaded cars was the maximum train this engine could handle on account of the water capacity of the tank being too small

for the distance between water stations, the tank holding 4,000 gallons, which clearly indicates the enormous evaporative capacity of the boiler.

On one of the trips the engine took 55 loads over Cerro Gordo and Philo grades, 40 feet to the mile, cut back to 16 inches, and this train could undoubtedly have been started from a dead stop on either one of these grades.

During the experiment the business on the road was such that we could not obtain cars enough to load the engine up to its full capacity, which will account for the low average train. On one of the trips, however, the engine hauled 91 loaded and empty cars, equivalent to 60 loads, and could have handled more had the capacity of the tank been sufficient to hold water enough to make the water stations.

On all of the runs the engine made good average freight-train time, which, with us, is 17 miles per hour. did not cause any delay to other trains, and fully kept up the train dispatcher's arrangements and calculations.

Considering the very low temperature, ranging from 20 degrees above to 18 degrees below zero, and the very stormy state of the weather, during a part of the time accompanied with a driving snow storm, I think the engine performed remarkably well, and fully demonstrated that Illinois coal could be used as a fuel in the present shape and condition of the fire box.

Having placed before you the facts concerning the working of this engine while under my supervision, I have a few remarks to make concerning the general construction of the boiler and fire box itself.

From my observations of this style of boiler I am led to believe that it would not prove successful in our service, in burning bituminous coal, from the fact that, owing to the peculiar shape of the fire box and the general construction of the boiler itself, it would unquestionably give a great deal of trouble after a few years' usage in the shape of constant attention and repairs.

In fact, during the short time in which the experiments were being made, it was necessary for us to remove the jacket immediately over the fire-box shell twice in order to caulk the seams, which began to leak so badly as to absolutely require its being done.

The flues also were a continued source of trouble, owing to their leaking very badly, which I account for by the necessity of opening the damper in smoke-box door in order to check the natural draft when the engine was standing still and at the same time steaming too freely. The allowing cold air to enter the smoke box, in my opinion, causing a sudden cooling and contraction that is very disasterous to the life of the flues.

Owing to the extra large heating surface, the steaming capacity of the boiler is more than sufficient to supply all the steam that would be required under any circumstances, and as far as this quality is concerned the boiler may be considered as being good.

The irregular shape of the boiler, as a whole, however, in my opinion, renders it liable to excessive straining through its liability of being subjected to extremes in expansion and contraction, which, in a comparatively short time, would necessitate constant attention and repairs; and the increased cost of caring for this kind of boiler would not be compensated for by the benefits derived from the extra good steaming qualities.

In general construction and arrangement of the machinery the engine was good and gave no trouble whatsoever.

In conclusion I will say that, in my opinion, this class of engine, the Consolidation, is the proper engine for through freight service in an economical point of view, owing to the capacity and traction of the engine being so great as to largly increase the size of the train hauled, and thereby diminishing the train service and expense.

JACOB JOHANN,

General Master Mechanic Wabash, St. Louis & Pacific Railroad.

On motion of Mr. Wilder the paper of Mr. Johann was received.

THE PRESIDENT—Gentlemen, you have heard the paper just read, and it will now be in order to proceed with the discussion of the two papers—the one presented by Mr. Wells of the Louisville & Nashville and the other by Mr. Johann of the Wabash, St. Louis & Pacific; before commencing this discussion there should be a committee appointed on applications for associate membership. What action will you take?

On motion it was agreed that a committee of three should be appointed by the Chair to receive applications for associate membership.

THE PRESIDENT—The Committee will consist of J. N. Boon, George Hackney and J. E. Morrill. The discussion on boiler construction will now

be in order. I should be very glad to have the discussion commence where it left off last evening. It was unfortunate that our time was up, because the discussion was just getting fairly under way. We have a large attendance here this morning, and I think mainly owing to the fact that the discussion on boiler construction is to be resumed at this time. It is a matter that is of very great importance and interest to every member, and I hope it will be thoroughly discussed.

Mr. FRY, New York, West Shore & Buffalo Railroad—I beg leave to propose that the paragraphs relating to Figs. 2 and 3 on the blackboard be read.

The Secretary read the paragraphs referred to in the report of Mr. Wells.

THE PRESIDENT—You have heard the paragraphs read relating to sketches on the board. I presume the members of this Association can present some very severe criticisms on some of the methods illustrated by the sketches. I, for one, must say that I unhesitatingly object to bringing the lap on top of the boiler. The only advantage, evidently, is to get rid of one seam; and I think the disadvantages of having the seam on the top of the boiler, and then cutting out through it in attaching a dome would more than counterbalance any advantage gained. The difficulty of fastening a dome there and getting tight work must be great; and then the strains tending to rip open the boiler must necessarily be concentrated at that seam. It is the apex of the half circle, and this being on the top, the strains there must be enormous, and it seems to me our present practice is very much stronger. I should like to have some of the members give their views on that point.

Mr. SEDGLEY, Lake Shore & Michigan Southern Railroad—During the past three or four years we have made quite a number of boilers, the side sheets coming up on top as represented in the sketch, only we use a lap seam instead of making a butt joint. These were made for a class of engines where the dome went through the cylinder part of the boiler, and I presume that is the English practice. You are well aware that with the majority of their engines the dome is on the cylinder part of the boiler, and, I believe, it is decidedly preferable to putting the seam on the side of the fire box—there is in that part of the boiler more expansion and contraction, because it is not perhaps so well stayed. The circle is not as perfect there, perhaps, as it would be upon the top of the boiler, and my preference is decidedly for making the outside sheets of the fire box two sheets instead of three—I should rather make it one. I see no good reason for not making our boilers in that way—we save one seam, and it is less work to make it in that way; and I believe it is decidedly preferable if we do not put the dome over the fire box, and if we do, I see no objection to making it so even then.

THE PRESIDENT—I would say, gentlemen (referring to the drawing, Fig. 3), that would indicate that the dome is placed near the back end of the boiler. I take it the drawing at E represents the back head, the dome being placed forward about as we place it in our practice. That must necessarily bring that dome right over this seam. It seems to me it must be very diffi-

cult to fit that re-enforcing plate, No. 4 (referring to sketch), around there with the seam butt jointed and welted each side, and get a good job. It must be very expensive if well done. I take it by the shape of that re-enforcing plate that it is to run out and receive the rivets through that welt, front and back; I can see no other object for it—that is to re-enforce the seam running longitudinally on top of the boiler. Now, if that plate was solid, if there was no seam there to weaken the plate that certainly would be unnecessary. I do not mean to be understood as advocating the idea of running longitudinal seams each side, down where they would interfere with the stay bolts; but I do believe that a plate on the top running down sufficiently to get the dome on a solid plate of iron is preferable to bringing the plates up and riveting them on the top and then cutting that out through the seam and riveting on the dome.

Mr. SEDGLEY, Lake Shore & Michigan Southern Railroad—My understanding is that the re-enforcing plate forms the welt for the seam. I see no reason why it should not. That was my understanding of the report.

Mr. JOHANN, Wabash, St. Louis & Pacific Railroad—I think (referring to sketch) that that is a reasonably good construction for stiffening the crown of the boiler. In the first place I wish to say that I am beginning to be pretty well converted toward abandoning the idea of lapping our sheets. I think that that is not as good as it might be. I think a great deal of the grooving is started in that way—the circle being irregular, the natural tendency is to make this ring round by working on that sheet, in expansion and contraction, in the same manner as when you try to break a piece of wire by bending it backwards and forwards. That is one reason why our joints sometimes groove so very deeply; and, in my opinion, some of our explosions are largely due to the same cause. Now there is no objection to putting the dome right over the fire box. I would throw the additional sheet over the outside and bring it down pretty well toward the centre of the circumference, butting the outside sheets, and branching it up to take the dome; that would give you full metal all around, and it would very materially stiffen the back of your shell. Now the general impression would be, what is the use of putting so much metal there? Well, that additional metal does not amount to a great deal in weight, and it amounts to very considerable in strengthening the back of your boiler, in every way making a more perfect job. I have two boilers, one of which I constructed by bringing the sheets up in the centre, and putting first an ordinary welt piece, about twelve inches, over there to secure the joint; with the next one I built I brought the sheets up and butted them in the centre, and it made a job so decidedly better that I continued to construct in the same way, especially with those boilers that have been under discussion before the Association. It does not cost much money; it makes but very little more labor, and that little additional weight is more beneficial than otherwise. It gives you that much more weight on the drivers; but it stiffens the boilers con-

siderably. I think that I shall practice it much more extensively; I think that it will make a decidedly better boiler, and that when the method is well developed that it can be done fully as cheap as by the other way, and that it will very materially lengthen the life of the boiler. I find that boilers that I have had on my hands, after they get a little old, will always be more or less grooved on the seams. I believe that is the original starting point of grooving, from the natural working of the sheet in trying to work itself into a perfect circle. When it once starts it gets along very rapidly; if not discovered in time it will eventuate in the explosion of the boiler. There may be some way of making it more perfect; but that is a very good way, so far as I can see. I am decidedly in favor of developing construction on this principle But to overcome the objection that you make in particular, and which, I apprehend, a very large proportion of the members would also make, that may be overcome very nicely by making those sheets come up to the centre, butting them and throwing an outside sheet over, which gives you an entirely smooth surface on the top that you can branch up and to which you can hang your dome.

Mr. Durgin, Rhode Island Locomotive Works—I would like to ask the gentleman what experience he has had that led him to adopt this double sheet. I understand he built one boiler without it; the next one he built with it. I would like to know what led him to adopt it?

Mr. Johann, Wabash, St. Louis & Pacific Railroad—What led me to adopt the additional sheet in the boiler, which has been illustrated here before the Association, was in order to get more thread to hold the stays. I could not get thread enough to hold the stay bolt, and that is the reason I threw that sheet down on both sides of the crown. After it was on the thing was so substantial that I adopted it, and believe that it is a material benefit to the boiler. We have not had a particle of trouble with those boilers; they have not leaked a simmer in any place. Both those boilers have made 135,000 miles. One carries 140 pounds and the other 150 pounds of steam right along, hauling passenger trains of not less than nine cars; from that to twelve.

Mr. Durgin, Rhode Island Locomotive Works—Would it not have been equally as well to make it a thick sheet in the first place?

Mr. Johann, Wabash, St. Louis & Pacific Railroad—It would have been equally as well, except it would not assist the lap. The thick sheet would have to do the work without any re-enforcement of the lap. I am now beginning to butt my joints; and, of course, I have to put a welt on the joint in some way or other to hold the sheets. I do not state that I consider this is so very great an advantage except that it does not cost any more than the other way, and I think it is a better job; and I am so well satisfied with the performance of the boiler that I shall continue it.

Mr. Durgin, Rhode Island Locomotive Works—Has the first boiler you built given you any trouble?

Mr. JOHANN, Wabash, St. Louis & Pacific Railroad—No, sir.

Mr. DURGIN, Rhode Island Locomotive Works—That one of them, so far as you know from your experience, is as good as the other?

Mr. JOHANN, Wabash, St. Louis & Pacific Railroad—Yes, sir.

Mr. FRY, New York, Buffalo & West Shore Railroad—It is interesting to know that the butt joint, where it has been tried either with the welt strip as illustrated in Fig. 2, or with the wide covering strip which Mr. Johann has used in his boiler, which has been so much admired and which has proved so successful, has given entire satisfaction. Now, in regard to putting on the dome, it sometimes happens that it is very difficult to arrange a dome on the barrel of the boiler without throwing the seam down into the water space. I asked a question, yesterday, to ascertain if any of the members had experience with the seams of the barrel a short distance below the water space. It sometimes happens, in designing a locomotive, that you have a very large dome, say 28 or 30 inches, and you do not like to get the seam close to the foot of the dome, and to get it just where you do want it puts it down into the water space; and many engineers are of the opinion that the seam is just as safe from grooving if it is six inches below the top of the water space as it is within the steam space; but if it should be found to be subject to grooving even a few inches below the water surface, you would then be obliged to put the seam up on top; and if the objections which our President offers hold good against placing the dome on the top of the seam, it is very difficult to design a boiler that will be satisfactory; but if the objection is only a fancy, and there is no mechanical reason why it can not be made perfectly safe to put the dome on top of the seam, it is a very valuable fact for us to know, for it will very often help us in getting up a new design. The suggestion that Mr. Forney makes, of putting on that heavy piece, necessitates also keeping the hole for the dome the same size as the dome. Many engineers have made a large dome but have made a small hole, which materially strengthens the sheet, and it will be interesting to note whether there is any experience in that form of construction, because you might get a very much easier way of strengthening your dome. In the former case the dome must be brought down and flanged and riveted to the boiler, the barrel sheet carried up and riveted to the dome, and, if necessary, a covering strip around the hole. A strengthening sheet, such as Mr. Johann uses, could be run around the hole that would seem to me to afford a very much cheaper and easier form of putting on our domes than that suggested by Mr. Forney.

THE PRESIDENT—I would say to the members I have accomplished my object in taking the position I did, which was to excite opposition on this question and draw out discussion in regard to butting joints together at the top of the boiler.

Mr. WILDER, New York, Lake Erie & Western Railroad—I think the discussion, yesterday, in regard to the liner Mr. Hayes puts inside his boiler would be an answer to Mr. Fry in regard to the practicability of putting

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a seam below the water line. Mr. Hayes says that he puts his liner in covering one-third of the circumference of the boiler, and he has no trouble whatever in furrowing above the point which the liner covers, and from that experience there would seem to be no objection to putting the seam down below the water line, providing that you do not go below the centre of the boiler, so that the sediment which settles from the water will not settle upon the joint. As long as the joint was above the centre of the diameter all the sediment would drop away from it.

Mr. JOHANN, Wabash, St. Louis & Pacific Railroad—I do not think that it is the sediment. I am merely giving that as a matter of opinion; of course I have not any facts to substantiate it. I do not think that the sediment has so much to do with the furrowing as the irregular shape causing the expansion and contraction. I know, in the case of a boiler explosion that came under my notice, that unquestionably the boiler let go just at the horizontal seam, and, as near as I can remember now, it was probably three inches below the water line. On investigation it showed that the sheets were furrowed and a large portion of it did not have more than about one-sixteenth inch of solid metal, and from all indications that was the starting point of the giving away of the boiler, and that seam was not more than three inches below the water line and above the centre of the boiler.

Mr. WILDER, New York, Lake Erie & Western Railroad—I only drew my conclusions from the argument made by Mr. Hayes yesterday, and his statement with regard to what he found when he used a liner which covers only one-third of the circumference of the boiler; but Mr. Johann's statement would seem to be testimony that the liner on one-third of the boiler would not entirely protect the seams from furrowing.

Mr. HAYES, Illinois Central Railroad—I would like to ask Mr. Johann whether that giving way of the sheet—that wasting away of it—is on the outside or the inside of the boiler?

Mr. JOHANN, Wabash, St. Louis & Pacific Railroad—It is on the inside.

Mr. HAYES, Illinois Central Railroad—Have you ever known this furrowing to take place above the water line?

Mr. JOHANN, Wabash, St. Louis & Pacific Railroad—I can not say that I have.

Mr. SEDGLEY, Lake Shore & Michigan Southern Railroad—I would ask Mr. Johann if, in the arrangement referred to, he examined the seam to know if it was uniform—if there was not some irregularity in the form of the boiler at that point? I ask for the reason that several years ago we had a case, I think, very much like that which he speaks of. To start with, it is very difficult to get rolls that will roll a sheet clear to the end, and therefore the circle is irregular at the end of the sheet, and boiler makers generally undertake to form it up with sledges, and sometimes do not make a very good job, and every time the boiler pressure comes on it there is a strain and there is a tendency of the sheet to give way on the inside. This boiler

that I refer to gave way for some five or six feet, but there were no symptoms of furrowing. In my experience I have never found any furrowing above the centre of the boiler. I should be very glad to know if such is the case, that it does take place two or three inches below the water line; for, in fact, I do not welt my cross seams if I can get them up within four inches of the water line.

Mr. JOHANN, Wabash, St. Louis & Pacific Railroad—In answer to Mr. Sedgley, I would say that it was utterly impossible to form any opinion of the condition of the sheet, for it was twisted out of all shape; and it was not simply a crack, it was a decided furrow, that was unquestionable, and on the internal surface it was furrowed out for a space of three-eighths of an inch and champered down in that way till it left about one-sixteenth inch of solid metal.

Mr. DURGIN, Rhode Island Locomotive Works—I would like to ask these gentlemen, who are familiar with this furrowing, if they caulk their boilers on the inside, and if they ever noticed any difference whether caulked or not? and if caulked, how and whether the workman does not start this furrowing in the first place?

Mr. JOHANN, Wabash, St. Louis & Pacific Railroad—There is some doubt in my mind as to whether a great deal of the furrowing is not started from injudicious caulking. I am not aware of any special instance where I have noticed that it was from caulking; but I am constantly quarreling with my boiler maker on the caulking question, so as to avoid that if possible. I have no doubt the trouble is very largely due to injudicious caulking; that and the matter of vibration has a very large share in the matter.

Mr. HAYES, Illinois Central Railroad—Why does not that take place above the water line if it is due to that?

Mr. FRY, New York, West Shore & Buffalo Railroad—I do not think that the furrowing is to be attributed to the caulking to any considerable extent. The furrowing of boilers is almost entirely confined to our Western friends and others who have very bad water. There is scarcely any furrowing of boilers where the water is good; and so far as we have obtained evidence from the members present, there is no furrowing above the water line and not very much just below it; and if we can only stir up some of our other Western friends who are so quiet here, but have just as much experience as the rest of us, and a great deal more than the most of us, and get an expression of opinion from those who have bad water and be able to locate the point at which it is safe to put a seam, we shall have done a great service to the machinery department of our railroads. I think it is very evident to all of us that the workman has not very much to do with it. It is not likely that all the good workmen are confined to the Eastern States and States that have good water, and all the bad workmen confined to the Western States where the water is bad. The probability is that the work done is about equal in the various sections of the country; but it is very important that we should know where

it is safe to place our seams; and if we can get any further evidence substantiating Mr. Johann's experience that furrows do sometimes take place even a short distance below the water line, we shall have a good warning then to keep our seams away up in the steam space. I would be very much obliged if the President, who has been so successful in getting some to speak, would stir up a few of the silent members to give their experience.

Mr. SETCHEL, Kentucky Central Railroad—A few years ago the road with which I was connected bought from a locomotive works five engines, the boilers of which had a long connection or throat sheet running out [indicating] thirty inches on the barrel of the boilers, leaving a flat surface without any stays whatever, and the seam probably about five or six inches below the water line. After one of the engines had been running about three months it exploded, blowing this sheet out. A close examination was made, and we found that it had worked itself off about in that shape [illustrating] by grooving above the seam. We then took in one of the other engines that happened to be in the round house; stripped off the jacket, fired up the engine, and the steam was soon visibly oozing out at the same point, and we immediately went to work and changed all these engines, putting in a short sheet and cross stays, and we found that all those boilers had commenced grooving at the top of the lap, so that they were dangerous to run, although in service only about three months. I am satisfied that the irregular shape above the water line or below it, will by that tendency of a boiler to work itself round groove and break off at the seams; but I believe that where the irregular shape is below the water line, then it is the chemical as well as the mechanical force that does the mischief. Every time the expansion and contraction takes place the chemical work is going on, and it grooves much quicker below the water line than it does above; but I have never yet seen a case when the surfaces were properly stayed and the boiler a true circle of any grooving above the water line. I do not think that there is anything mysterious about the grooving in either case. The tendency of the boiler is to draw in a circle, and if there is the least working of the sheet it is only just a question of how many times that can come and go before it breaks off. I think the pitting of the sheets much more mysterious, but not as dangerous. When you take, sometimes, the bottom of a tank or the bottom of a boiler and you find pits as large as a dime scattered over the bottom of a boiler, in some places thick and in some places only occasional ones, I confess I am entirely unable to account for it. Sometimes I have seen a single hole as large as a dime extend clear through the sheet, and all around it the sheet would be of the original thickness. I know this question has been discussed before. We have had it a great many times before us; but a great many new members are here who perhaps can give us some light on the subject, and it is certainly a subject that is interesting.

Mr. WILDER, New York, Lake Erie & Western Railroad—Some years ago we had a number of engines built with a long gusset, similar to what Mr.

Setchel describes, and had very much the same trouble with them, only we were not unfortunate enough to have any of them explode, and by putting on a welt over all those seams we never had any trouble with them. They ran twelve years after that; but I thought at the time, and I still think, that the position of the grain of the iron had a good deal to do with the trouble—that the grain ran the wrong way; or, in other words, it ran longitudinally with the seam. In regard to pitting, have any of the members who are troubled with pitting had an analysis made of the scale or substance that immediately surrounds the hole or pit, and that which is a little further away, where there is no pitting on the same sheet, to see if there is not some different chemical substance that deposits itself right over the hole, having a tendency to combine with the iron and wear it away?

Mr. HAYES, Illinois Central Railroad—I have attributed this pitting to defects in the metal when it is rolled, from this fact: I sometime ago bought some sheets as smooth and nice as any metal that I had ever seen, and allowed it to remain out of doors; there came a heavy shower upon it, and it lay there two or three days. When we put that steel in the shop and put it through the rolls, there were cinders or something in the steel that after hammering and working the sheet came out, and the surface looked like a man who had come out of a spell of small-pox, pitted all over. I have always attributed this pitting in the sheets, away from the seams, to defects in the metal when it is made, and the working and additional strain of the boiler perhaps loosens it and it gives this chemical action a chance to work and eat it out. I am pretty certain in my own mind that that is the cause, because some metal will do it a great deal more than others. We used to get some from the Wyandotte Mills below Detroit, which was very much subject to pitting; and I think it is entirely owing to the defects in the metal when it is made

Mr. SEDGLEY, Lake Shore and Michigan Southern Railroad—We never have pitting upon the ordinary seams around our fire boxes. I have never known a case where that took place to any extent; but the same boilers with the seams below the water line are the ones from which we suffered the most. I would like to ask if any gentleman here has had any trouble with the ordinary seams in fire boxes from pitting?

Mr. SETCHEL, Kentucky Central Railroad—Mr. Sedgley has made the objection I anticipated to Mr. Hayes' theory, viz.: That pitting never occurs above the water line; and if it is in the sheets why does it not occur in the steam space as much as below the water line, or in the perpendicular sheet of the fire box?

Mr. WILDER, New York, Lake Erie and Western Railroad—One of the members suggests to me that if Mr. Johann's boiler exploded after three months, that the time was very short for a furrowing to take place, and we would like to know if a particular examination was made on the inside of the boiler to see if it was a furrow.

Mr. HAYES, Illinois Central Railroad—We have had our sheets pitted

somewhat on all parts; but not to that extent as on the cylinder part of the boiler, where almost invariably they pitted slightly on the inside; but still I am strongly of the opinion that it is from the defects in the metal.

Mr. Ross, New York, Lake Erie & Western Railroad—We took three fire boxes out last summer, and just above the ring, for the entire distance around the fire boxes, they were grooved half the depth of the sheet. It looked to me as if it was from deposits, just above the ring, pitting or grooving the entire distance around the box. We run through a very limey country and our water is very hard.

Mr. Johann, Wabash, St. Louis & Pacific Railroad—I entirely agree with Mr. Hayes. I think it is imperfect material; I do not think there is much chemical action, but imperfect rolling of the material that causes the pitting. I think there are pits that do not show in the original shape; and after they get to work they gradually drop away and form the pitting. I have not made any tests upon that; but I look at it in that way. From where we get our boiler material I keep constantly hammering at those people to be more careful in rolling their plates, and we do get better plates.

Mr. Hollister, Savannah, Florida & Western Railroad—I think the most of this grooving grows out of the vibrations in the sheet. We have adopted the seam that I have tried to illustrate there [referring to the blackboard]; see Fig. 5—a welted seam with three rows of rivets; for this reason, that we wanted to get a good caulking joint; we wanted the rivets comparatively close together, and by putting them in that way [illustrating] the sheet is weakened right through the line of rivets; but by putting this outside row of rivets twice the distance apart it strengthens the caulking joint. The rivets being close, the welt underneath taking these outside rivets, strengthens that joint and makes the seam as strong as the metal that lies between those spaces; that is one reason. Another reason is that we think the vibrations concentrate along on the edge of the lap. These vibrations here [indicating] have a chance of dying out as it were, the sheets not being held close together, which is the matter spoken of in many of the discussions, illustrated by an indirect pull. By making this lap this way we put a strain in that joint, something like a simple fork connection, giving a more direct pull. While we have good water we occasionally have sheets crack along the seams, and we think it is owing to the concentration of vibration at the edge of lap.

Fig.5

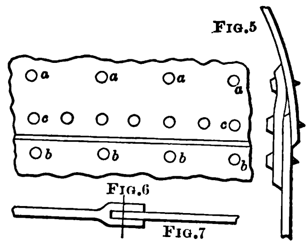


Fig.6

Fig.7

Mr. SEDGLEY, Lake Shore & Michigan Southern Railroad—I move that the discussion of this portion of the report be closed.

[President recognized Mr. SELBY, who made some remarks which were not distinctly heard by the reporter. He was understood to say]:

I had occasion to take out the bottom of a boiler and I put in a solid sheet. The boiler has been running four years now; and about six months ago I took out the flues and examined the sheet and found it in almost as good a condition as it was when I put it in. I am just trying the experiment of solid sheet below the water line.

The motion to close discussion was carried.

THE PRESIDENT—The next business is the reading of the report of the Committee on the Construction of Parallel Rods; but I would suggest that we defer that until our afternoon session, or until our noon discussion, inasmuch as it will need some illustrations, and perhaps occupy our time from now until noon with other matters. We have a gentleman present from England, Mr. David Joy, an eminent engineer, who has come over here to attend this Convention, and has kindly offered to read a paper, and I would ask for the unanimous consent of the Association to have the paper read at this time. If there are no objections we will now listen to the reading of the paper by Mr. Joy.

Mr. JOY came forward and was introduced by the President, and read the following papers:

Paper on the Joy Valve Gear.

GENTLEMEN—I am here, by the kind permission of your worthy President and Advisory Committee, to say a few words in regard to the special type of valve gear designed by myself, and the introduction of which has brought me to this country.

With the distinctive features of this valve gear, I believe, most of you are more or less familiar. The majority of you have had diagrams and descriptions placed in your hands, and have doubtless examined them. It has also been widely commented on, illustrated and described by the railroad and mechanical journals, notably in the New York Railroad Gazette of January 13 and the Chicago Railway Review of May 6 last, and in that way also presented to you. I do not, therefore, now propose to take up your time by repeating what has thus been widely published, but rather to continue the subject down to the present time, and, if you permit me, to hear and have the opportunity of replying to any criticisms or questions which may suggest themselves to you on any points in

regard to which you may be in doubt or difficulty in reference to this valve gear.

I, of course, now know more about my device than I did four years ago, prior to the time when I had practical experience of its actual working. It is just the knowledge in that way gained that I now by your courtesy and permission expect to be able to communicate.

One of the two sheets handed to you this morning is specially devoted to marine, stationary and other engines, and contains some information as to what has been done with this gear in England. The other specially describes the method of adapting it to American locomotives. With these diagrams before you, you will, without difficulty, be able to follow the remarks I now proceed to make.

This gear was originally devised for marine engines, but it may easily be applied in almost every conceivable form to suit not only locomotives but land engines, launches, rolling mill, traction, steam plow, hoisting and other engines, to all of which varieties it has been successfully applied in England.

When I undertook to apply it to American locomotives I was pleased to find that they really seemed to have been actually designed by anticipation for the reception of this gear. For instance, the valve chests are placed on the top of the cylinders, whereas in the case of English locomotives they are put between the cylinders, so that an English master mechanic on taking up my gear has to entirely alter the type, but which they have not hesitated to do to secure the advantages attending the use of this gear. As applied to American locomotives I laid it out very simply and without any alteration of the framings or in fact any other part of the engine.

A question has been raised whether the swaying of the engine would not produce a rise and fall of the connecting rods, including that part of them from which the motion to actuate the valve is taken. This question was originally raised by Mr. Webb, the superintendent of motive power of the London & Northwestern Railway, when he first commenced to apply the gear to his engines. For upward of six months he and I exhaustively investigated this particular question on a full-sized model, and he eventually concluded that the error arising was so slight and imperceptible as to be unworthy of notice.

Now as to your American locomotives, although, as I am happy to say, the master mechanics of some of your leading railroads, after studying the question, have expressed the same opinion as Mr. Webb, yet I am willing, for the sake of argument, to have the matter gone over anew and independently. The use of equalizing levers between the springs, allowing one wheel to take up a part of the motion from the other, seems to imply that ordinarily there may be more movement of the axle boxes here than on English roads, and that a varying action occurs at the crank end of the connecting rod, though the other has no motion. The amount, consequently, of which we should have to treat would be the amount existing at the point from which we take our motion for the valve, being from one-third to two-fifths of the amount of the motion at the pedestals.

To meet this case, where if it is desired to overcome any slight disturbance, I have designed a frame to carry the centre of the quadrant lever, that is the slide case carrying the block in which the valve meter has its fulcrum. This frame is fixed at the crank end to the axle box, and at the other end pinned to the frame at a point at a distance equal to the length of the connecting rod. The frame, consequently, will move with the axle box, and will give to the centre of the slide case a vertical motion exactly equal to the vertical motion of the connecting rod at the point where the motion is taken to actuate the valve; therefore, any irregularities arising from the action of the axle box on turning curves or from uneven track is thereby entirely eliminated.

This is suggested as a means of correcting, theoretically as well as practically, every error which, owing to roughness of road bed or sinking of springs, may in any case be found to exist.

I may, however, say that ever since the first engine came out on the London & Northwestern Railway I have exhaustively investigated this subject, and when running on freight engines at 40 miles and on passenger engines at 60 miles an hour, I have been quite unable to detect any defect whatever in the blast, even when the engine has been pulling hard and bumping over points and crossings, and under other circumstances which, if such error existed to any appreciable extent, would inevitably have made it apparent.

English locomotive superintendents, after closely studying this question, have unanimously come to the conclusion that no percept-

ible disturbance exists, and in proof of the good faith of this opinion and of my statement in regard to it, I adduce the fact that they and others are now generally specifying this gear for locomotives for use both in England and in the British colonies, and in Central and South America. For use outside of England they are specifying in all cases outside cylinder engines of the American type, and indeed almost exactly like your own.

As to the nature of the railroads in the British colonies, I am sure I need not tell you that so far as the track is concerned they are the counterpart of western American railroads. They are pioneer roads, in almost every case hastily and economically constructed for the purpose of opening up the country to colonization. Built as they mainly are through wild territory and at a low cost per mile, how can they fail to possess many of the same features as your own pioneer western roads, constructed under analogous circumstances? When, therefore, I am able to put my finger on the fact that reputable engineers, whose standing and acquirements are fairly evidenced by the fact that they act for the British government, have, for these rough colonial railroads, after due investigation of the merits and demerits of this gear, adopted it for present and future use, and have now actually arranged for a large number of locomotives of American pattern fitted therewith, forty of which are either now building or have already been built or dispatched, I am tolerably sure you will feel that there is some foundation for my claim that even without the frame described (and which in no case has been used) there is no ground for fear of failure on the score referred to. The consulting engineers of the Indian state railways (which for dustiness are unequaled, and possessed of all kinds of irregularities of track) have likewise entered into an agreement with me concerning the use of my gear thereon. How similar they are in regard to roughness of track to many of your own railroads may, to some extent, be realized from the fact that they find it necessary, generally, to use the equalizing levers with which you are not unfamiliar.

I now refer to one of the advantages of this gear which seems to be frequently overlooked. It is illustrated on the marine engine diagram in your hands, Fig. 15, and described near the bottom of column 4. It is there pointed out that the action produced by this motion is really a series of accelerations and retardations of the

motion of the valve. The first acceleration occurs at the commencement of the admisson of steam, and causes the port to suddenly open wide, whereupon the retardation immediately occurs and the valve is held wide open until the proper time for the second acceleration arrives, viz., at the point when the valve begins to close. A much sharper cut-off than is given by the link motion is thereby attained. Thus, although a shorter stroke may be given to the valve and a less absolute opening, you will get, during a given cut off, as much steam into the cylinder, because the action of the valve, though entirely free from jerkiness, is more like that of a tappet valve—opened instantly, then resting full open, then suddenly closing. Consequently, by retaining the same lead as is now given for a link gear *at the point where most of the work is done* a much better port, more quickly opened and closed, is obtained than can be accomplished with the link gear.

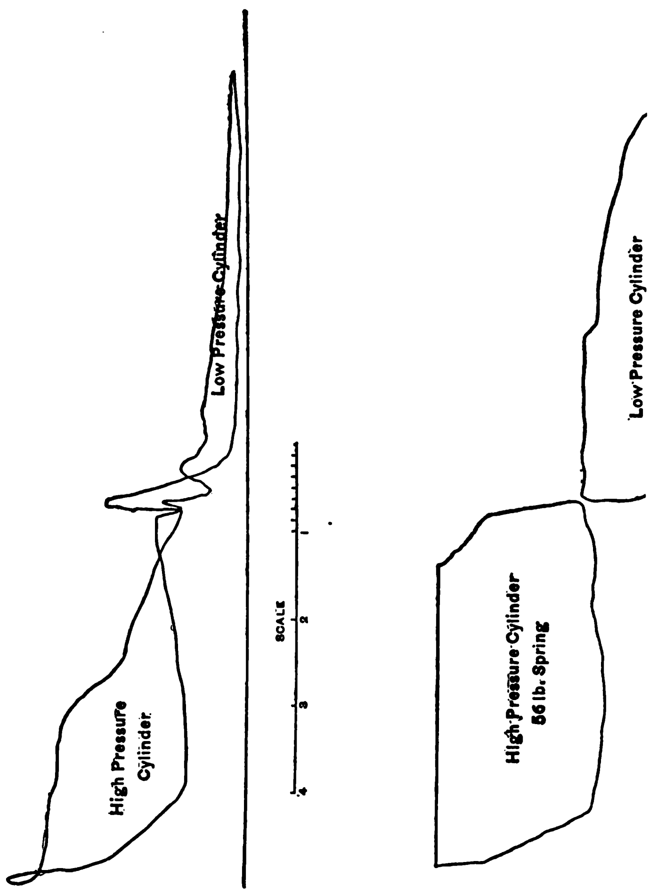
To illustrate my present practice, resulting from experience, I may mention that I have just designed the gear for some large fast passenger engines with 18 by 24 inch cylinders and four 7 inch coupled wheels. In this case I am getting a full opened port of 1½ inches at 80 per cent. cut off, and a constant lead of three-sixteenths.

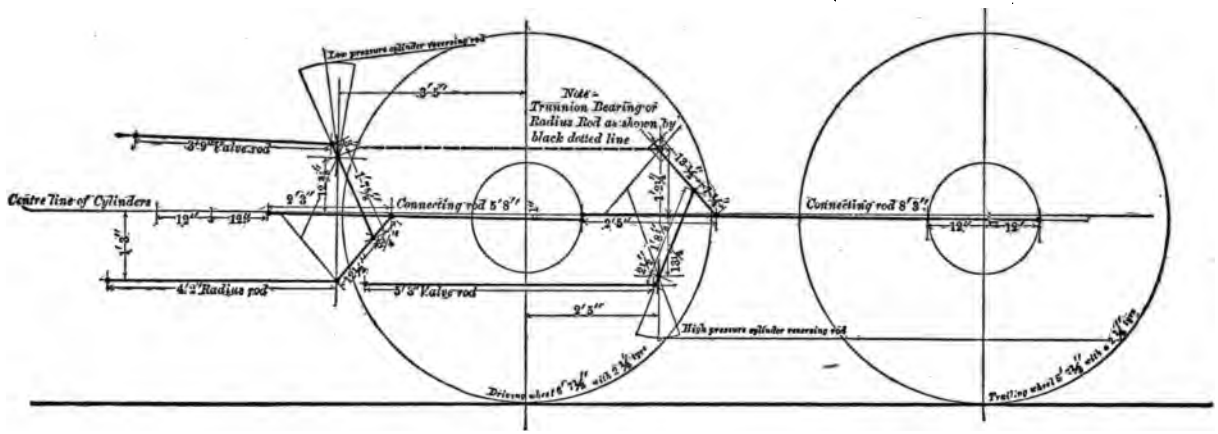
As to compression with this gear, owing to the peculiar movement given to the valves (that is, the seiies of accelerations and retardations), while the lead is opened later but quicker, so is the port shut for compression later but quicker, leaving the alternative, if wished, of adding lap on the exhaust side, thus retaining the action of the steam a little longer, and getting the same compression as with a link motion, or, as in the case of marine engines, doing away with the necessity of a special expansion valve, and allowing the main valve to be used for expansion, as the compression is not enough even at a cut off of ·25 to injure the action of the engine. In proof of this I may mention that the British admiralty are now having constructed, by Messrs. Maudslay, the well-known engine builders, two pairs of engines for a twin-screw armored vessel with my gear, each pair to indicate 2,500 horse power, and which engines will depend entirely on their main valve for the cut off.

For river service in the East Indies this gear is being extensively used by the government on large and fast dispatch steamers. Nine such steamers are now being built from the same patterns. It has

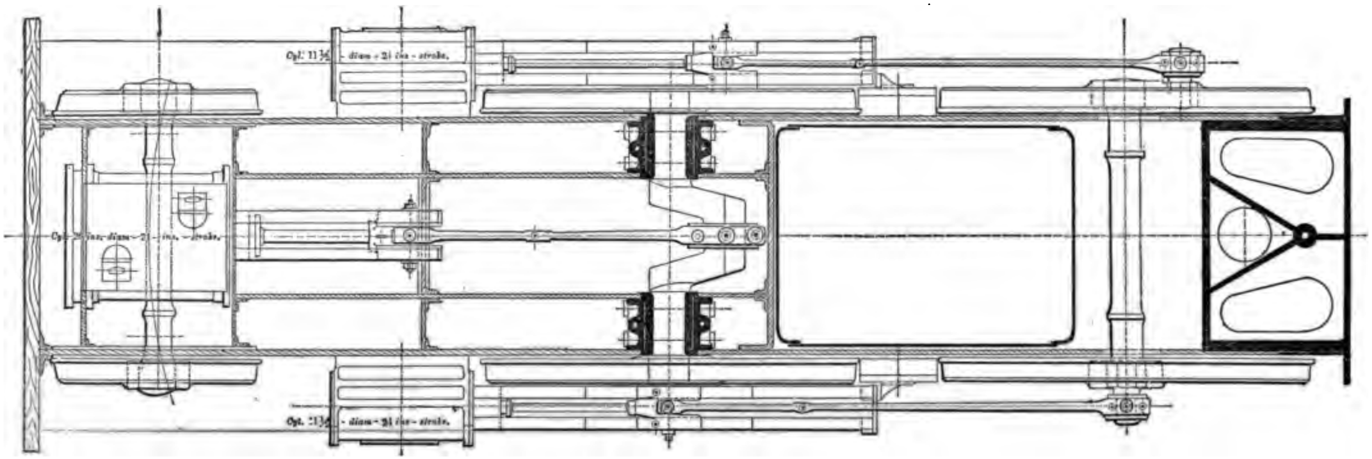
also been applied to rolling mill engines, in one case with 6
cylinders and 4 feet stroke, where, in rolling steel, repeate
rapid reversals are constantly occurring, and these engines ar
run at high degrees of expansion when finishing the billets.

The statements which have been made as to the rapid adn
and exhaust of steam have always been verified by the squ
and fullness of the indicator diagrams, many specimens of w
have from various quarters.





Valve Motion Diagram of Webb Compound Locomotive.



Sectional Plan of Webb Compound Locomotive.

-er Mr. Joy had finished reading his paper he asked permission to read -per on the Webb Compound Locomotive. Permission being given, he the following paper:

Paper in Regard to Webb's Compound Locomotive.

ENTLEMEN — By the kind permission of your President and ncil I say a few words in addition to what I have said in regard ny valve gear, but on another subject, which is receiving a great of attention from master mechanics and also from the directors ailroads on the other side of the ocean. I hope that I have not ır exhausted your patience, but that I may have the pleasure to mand your attention and interest still further. My subject is Compounding of Locomotives as it has been carried out by Mr. ɔb, the chief superintendent of motive power of the London Torthwestern Railroad Company, which is probably the largest vay in England. Perhaps I hardly need say that I am now ıking of Mr. Webb's work, and not of my own, the credit or t of any advance here being his not mine. I have, however, ı furnished by him with all the information which I have the ısure of laying before you, in addition to which I have, from e to time, made myself familiar with all the work, riding on the ine, and otherwise watching the progress of this improvement.

'he question of coal or coke consumption has with us, in Engl, always been a very serious one, so that all devices for economing fuel have received much practical attention.

Jndoubtedly many of you are aware that in England, a few years , a commission was appointed to investigate and report upon the l fields of England, and on this report to found an opinion as to probable duration of the coal supply. I do not remember the ct figures, but the date of the exhaustion of the supply appeared ıe uncomfortably near.

n presence of this contingency, it is no wonder that devices innerable have been before the English public claiming to accomh all that was required in the way of economy; but, on the ıciple of the survival of the fittest, our English locomotives have .ined nearly the old form in which they appeared thirty or forty rs ago.

'he experiments made in France and Germany in the compound-

ing of locomotives have been before you in the mechanical papers. My province is to tell you all I can of what has just been done in England, and then to answer any questions that may arise thereon so far as I am able.

About three years ago, when I first introduced my valve gear to Mr. Webb, he told me that he proposed to build a compound locomotive with a view of economizing the consumption of fuel, basing his expectations on the great saving that has in recent years been made by the introduction of the compound system for engines at sea.

With very cautious and measured steps has the investigation of the question and the designing of the details been carried out, resulting in the engine of which blue prints and photographs are now before you.

Of this engine and the peculiar object aimed at by the divergence in its construction and ordinary practice I will now endeavor to give you a short but I hope clear description.

If you are at all acquainted with the standard express engine of the London & Northwestern Railroad, you may fairly say, on first sight of the photographs before you, that the new engine has been a very slight departure, in appearance at least, from such standard type. Such in reality is the case, and this is a great advantage, the real difference being one of total alteration of principle. But you will readily see, if with the altered principle the details can to a large extent be retained, the change is not such a one as to prohibit or, in fact, militate against the introduction of the new principle. In the new engine the same boiler, wheels, frames, etc., and, to a large extent, valve gear and other details are retained.

Now to describe the engine. As I have said, she has the outward appearance and whèel bearing of the ordinary four-coupled express engine, only the trailing pair of wheels are not coupled to the driving wheels (using the usual nomenclature), but are driven independently by a pair of outside cylinders, 11½ inches in diameter and 24 inches stroke. They are fixed to the outside frames just in front of the driving wheels, where the sand boxes are usually placed. The motion bars are carried back beyond the driving wheels to a bracket from the frame, and these carry the valve and reversing gear, which is of the Joy type. This pair of wheels, so driven, have their cranks

set at right angles, and so far we have an outside cylinder engine with single drivers behind the fire box, but the exhaust steam from these cylinders is passed through a receiver formed of copper pipes surrounding the inside of the smoke box, where it takes up the waste heat from the tubes and then passes to the low pressure or expansion cylinder, the dimensions of which are 26 inches in diameter and 24 inches stroke. This cylinder is placed in the usual position for inside cylinder, viz., under the smoke box, and by a single-throw crank drives the middle or driving wheels, the Joy valve motion being here used also. Thus both pairs of wheels are independently and separately driven, and thus are combined all the advantages of the coupled engine with its disadvantages, and all the advantages of the single engine without the disadvantage of its liability to slip. In fact, for all practical purposes, you have two single engines coupled by the steam between them and the rails beneath them. You also save the coupling rods with all their attendant evils, the liability to break at high speeds, rigidity and harshness in running around curves, causing skidding of either inner or outer pair of wheels; and so adding friction, the great source of all wear and tear and the prime cause of the necessity of repairs.

Next as to the handling of the engine. This is practically not different from that for the ordinary engine. There is not the least difficulty in starting, as the two high pressure cylinders have their cranks at right angles. So far the engine is in the position of an ordinary locomotive, but there is in addition a valve at the command of the engine runner by which he can at will admit live steam direct to the low pressure cylinder, thus giving him three cylinders to start with, though this is not found to be at all necessary. Meanwhile the first exhaust from the high pressure cylinders passing at once to the low pressure cylinder on the enlarged area of piston, the full power of the engine is at once developed.

This power being divided between the two pairs of wheels, there is no more tendency to slip than with the ordinary four-coupled engine with the same weight on the wheels—indeed much less, for continuous slipping is checked by each set of cylinders controlling the other. Thus, if the wheels driven by the high pressure cylinder slip, they at once, exhausting into the low pressure cylinders, check themselves by back pressure, while the surplus power thus

over to the low pressure cylinder, if enough to cause slipping, qui
exhaust that pressure, and thus a balance is secured, and both pull equally, the action taking place being really an automatic ventive of slipping.

We now arrive at the main object in the designing of this engi namely the saving of fuel, which, as I have said, is with us a preci commodity. As to this I will quote Mr. Webb's figures.

When I left England, at the end of May last, this engine, af some desultory general work, had been working continuously duri the month of April, running the Irish mail on the London & Nort western Railway, the train usually, from its speed, called the "Wi Irishman," and scoring to the end of April about 7,000 miles. I daily work, from Crewe to London and back, is about 336 mile The average load on the up journeys is 8.3 carriages of the Londo & Northwestern large six-wheel type, each weighing about 12 ton or, without engine or passengers, about 100 tons. On the down tri the average load was 11.2 carriages, or about 134 tons.

The greatest load the engine has taken was 16 carriages equ to a total load with engine of 260 tons (English), running at Nortl western railroad speeds, the figures of which I regret not to hav with me, but which are not much under Great Western Railwa speeds, the quickest of which is the "Flying Dutchman," 76 mil in 87 minutes.

The average consumption for the month, including lighting fire was 23.2 lbs. of coal per mile, as against the ordinary engine min mum of 30 lbs. per mile doing the same work.

This, I think, may well be considered a satisfactory result for first month's working, for we may well assume that under such ci cumstances the best result attainable has not been accomplished.

Mr. Black, Cincinnati, Hamilton & Dayton Railroad—I would like ask how many levers it takes to start those cylinders on the Webb engine?

Mr. Joy—On the present large compound we have two levers. That merely experimental; they are both to be combined in the future engine; b it was for the purpose of taking the steam off the high pressure cylinde because you use the high pressure cylinders linked up and the low pressu you give full tilt to. Mr. Webb has arranged, and I believe I have had tl pleasure of assisting him in that, so that one lever will throw the engi from back to forward. You have an accelerating lever by which you can c

off from the high pressure cylinder precisely as in marine engines; you can at the same time cut off sharper with the high pressure because you do not want to do it with the low pressure; you want to handle all your expansion with the high pressure cylinder. That is the present course.

A recess of ten minutes was taken to allow members to examine the drawings accompanying Mr. Joy's paper.

THE PRESIDENT—Before entering upon the discussion of the paper just read by Mr. Joy, I would like to give Mr. Raymond an opportunity to make a statement before the Convention in regard to the absence of a report on the subject of Smoke Stacks and Spark Arresters. It will be remembered, perhaps, by those of you who were present at our last Convention, at Providence, that a committee was appointed to consider the question of smoke stacks and spark arresters, and that Mr. Raymond was especially delegated, I think, to look up the data and furnish material for a report. Mr. Raymond will be very glad to tell the Convention the reasons why a report has not been presented to the Convention.

Mr. RAYMOND, Western Railroad Association—I was not a member of the Committee, or responsible at all for what it might do. It is due to that Committee, however, that I should explain why that report is not here. It is a very important subject and a very long-winded one, and the method of investigation which the Committee adopted in the matter was to examine all the patents ever granted on smoke stacks and spark arresters, and to ascertain from an examination of those patents what lines of development the inventors had followed, which is a work of no mean dimensions. That work, which seemed to me to be the only proper course for the Committee to follow, has not been completed. It is a matter which takes a great many weeks to do, that single thing alone, and all the officers and employees of my association have been so busy with matters pertaining to litigation, which was pressing, that they have not had time to complete nor have I had time to review it. That will be done, however, and the suggestion that I make is that the course of the Committee be approved and the Committee continued another year. It would be impossible for the Committee to have completed their examination and investigation, and especially any experiments so as to have brought any results. I therefore make this as a report of progress, and suggest that the Committee be continued for next year.

THE PRESIDENT—I presume that Mr. Raymond's remarks would really take the form of a motion that the Committee report progress and that the Committee be continued for another year.

The motion was carried.

THE PRESIDENT—The hour has arrived which we have set apart for the discussion of special subjects, and without the action of the Convention it will now be in order to discuss any questions that members may bring forward, and I would suggest, if there is no objection, that the discussion of the

paper read by Mr. Joy be deferred until 1 o'clock, being made the special order for that hour. There may be a few questions that some members would like to ask him in regard to his valve motion, which might be interesting to us all.

Mr. WILDER, New York, Lake Erie & Western Railroad—I would like to ask if we propose to have two sessions to-day, or are we to continue this session up to the time when we take our final adjournment? If we do that we will probably not get through with our business, and I think that we had better adjourn very soon after these questions are read for dinner, and meet again at 2 o'clock for an afternoon session, and I now move that we adjourn at 1 o clock to meet again at 2 o'clock for an afternoon session.

The motion was carried.

The President proposes the following question: What is the Best Method of Welding Tubes for Locomotive Boilers?

THE PRESIDENT—I suppose it is incumbent on me to start the discussion. I presume a great many of the members of the Association are continuing in the old-fashioned way of welding tubes by hand; I am for one. I understand that there are in the country master mechanics who are using very much improved methods over the old way, and I present this question to draw them out and find out whether there is not something better in the way of welding tubes than to put them on the horn of an anvil and weld them with a hammer. I know that there are several machines that have been designed to weld iron tubes, and I would like to get at which is the best. I propose to procure a machine for welding flues, and I ask the question for information. I do not want to make a mistake in getting a machine. I should be mortified to buy a machine and then find I had made a mistake.

Mr. FRY, New York, West Shore & Buffalo Railroad—I made a very careful investigation of the subject you refer to a short time ago. I was led to do so from the fact that a gentleman with whom I am very well acquainted, who was a superintendent of motive power of the Chicago & Grand Trunk Railroad running from Port Huron to Chicago, had many years ago invented a machine for welding flues. I had seen it in his shop. It was made in a very rough manner out of material that he could find lying about the shop, but it did the work very effectively when I saw it; but I had heard nothing of it since. I visited his place a few months ago and I found the blacksmith was actually using the tool. I let him know that I was acquainted with the superintendent and drew him out as to its merits. I found that it had been working constantly for five years; that it had cost very little to repair it, and that it was an extremely satisfactory method of welding tubes; that it had very largely reduced the cost and enabled them to do the work very much quicker, and what was more satisfactory had so increasd the certainty of the work that they had abandoned the usual hydraulic test after welding. I don't know that this machine has ever been made for the

market; indeed I believe it has not; because I inquired if I could buy one and was told I would have to get one from the superintendent. The rapidity with which it works is wonderful. I then visited the shops under the charge of Mr. Sedgley and found a tool working on an entirely different principle—it was a roller—the first machine I saw was a steam hammer. Mr. Sedgley was using a tool which I believe is in the market and can be purchased. They both did their work equally fast; about seven seconds is the time taken to weld a tube, and apparently they do this work equally well. There are some advantages in the steam hammer which lead me to think it the better tool; but, probably, another person would prefer the other. But it did seem to me, after making that examination, perfectly extraordinary that we should have been going on with old hand welding so long. When two different machines are in operation which so successfully performs this very necessary work of welding tubes, I think it is very wonderful that there are not more of them used.

Mr. Sedgley, Lake Shore & Michigan Southern Railroad—I would like to ask the gentleman last up what portion of the work the machine that he saw in Canada did towards preparing the tubes for welding. Does it cut off the tubes or do the tubes have to be cut off in a lathe before they go under the hammer? We are using a machine for that purpose; we have had it in use, perhaps, two or three years; it does all the work. You take the tube as it comes from the boiler, it cuts it off and scarfs it at the same time it cuts it off, the pieces are then put together and welded. I would state, however, that it takes a different roll for each operation. Those machines, under ordinary circumstances, will weld about 100 tubes a day, costing probably (we use very cheap labor) 2½ cents per tube for the labor. It does the work so perfectly that we never test the tubes with hydraulic pressure. We never have a leaky tube from the weld; and in order to make a comparison of value I should like to know what proportion of the work this machine, which Mr. Fry speaks of, does. Of course you all know it is an expensive job to cut the tube off in a lathe before you scarf it. It is also some expense to cut the piece; but if it can all be done at the same heat at which the scarf is prepared, I think there is a decided gain for the machine that does that.

Mr. Prescott, Pittsburgh, Cincinnati & St. Louis Railroad—We are using a machine similar to that which Mr. Sedgley describes. We take the flues from the boiler just as they are; in cutting off the end we cut it with revolving rollers and scarf it at the same time, and then change the rolls when we commence welding up, and we think we save a good deal by it; I have done 220 flues per day. The pieces have been properly scarfed before with the other set of rolls. It saves the heating of the flue, after it is welded, to be annealed. When we weld them we place them at once into dry sand in a box and save that operation; then, when we get the length of the flue, we cut the other end off and we set that in the sand, and the cutting and welding is all done. The cost is but 7 cents a flue to take them out,

weld them, fit them up and set them again. We do not have to test any of our flues; if there is any imperfection in the flues you can see a black streak which will indicate it, and we throw that out; but we do not have any trouble with that at all. The possible amount it can do depends altogether upon the amount of fire you have to do the heating; you can weld them just as fast as the man can put them in the machine and take them out. The man welding the flues has full control by a treadle. I think it is the best thing that has yet been invented. It is made, I think, in Cleveland; I forget the name of the maker just now.

Mr. FRY, New York, West Shore & Buffalo Railroad—Replying to Mr. Sedgley's questions, I may say that the tool I saw at Port Huron did not cut off the ends, this was done in a lathe; all the other work was done by the machine. It scarfed the ends and drew down the end of the tube and welded the two together, and then drew down the end for the copper ferrule which was used. The cost per tube given me was, curiously enough, just the same as that mentioned by the last gentleman. In each case the people using the tools thought the one they used the best. It seemed demonstrated, to my mind, that they were excellent machines for doing that work.

Mr. HAYES, Illinois Central Railroad—I would like to ask Mr. Fry if he knows about the cost of this tool that he saw in Canada.

Mr. FRY, New York, West Shore & Buffalo Railroad—The foreman of the shop told me that they had made the one they had themselves. It was very roughly made out of odd material that they had picked up, and probably did not cost them a hundred dollars. The superintendent of the works told me that they had never sold any; that, however, was some time ago. He said that if he did sell any he did not propose to sell cheaper than any body else. He said, "If you want one you will have to pay me whatever the market price is." I do not suppose, unless some manufacturer would take it up, that it would have a price proportionate to its first cost.

Mr. PRESCOTT, Pittsburgh, Cincinnati & St. Louis Railroad—The machine I had reference to is sold for $600.

THE PRESIDENT—It seems to me, gentlemen, that in a matter of this kind the first cost of the machine is of very little importance, always provided we do not get swindled in paying more than the machine is worth. But the interest on the amount saved by the use of those machines, on any large road, would soon pay for the machine even at $600, which is a large price; but on the roads in the western country cheap welding is a very important matter; and a road that has 300 to 600 engines has use for that machine all the time. Perhaps I ought to qualify that a little. If a man can weld 200 a day, they would not have use for that all the time. The evidence presented here now is that we have two machines in use that will do the work and do it satisfactorily—one is not in the market, it has merit undoubtedly; the other is in the market, as I presume, and, I suppose, Mr. Sedgley can tell us where to get a machine if we want one.

Mr. HACKNEY, Atchison, Topeka & Santa Fe Railroad — I have got two of those machines running, and all that has been said about it I can endorse. I have not much to say any more than that; but they are a perfect machine for flue welding.

Mr. SEDGLEY, Lake Shore & Michigan Southern Railroad — I will state, for the information of the gentlemen present, that those machines are made at Cleveland. We had the first one, I think, put in our shop; and, I think, many of the members, perhaps, saw it two years ago when the Convention was at Cleveland; they are made by a small manufacturer, and if any of the gentlemen want to make any inquiries I should be happy to answer their questions at any time. I also have brought with me some specimens of the tubes which I should be glad to show to any of the members who wish to see them.

THE PRESIDENT—I would suggest to Mr. Sedgley if he has any specimens of the tube welding to bring them in.

MR. WILDER, New York, Lake Erie & Western Railroad—I move that the discussion be now closed.

Motion carried.

THE PRESIDENT—I have another question, What is the Best Form and Material for the Construction of Driving Boxes? presented by Mr. L. F. Lyne, one of your associate members.

Mr. LYNE, American Machinist—It is customary, upon most railroads, in making driving boxes, to take the iron castings and put them upon a slotter and slot a hole out for the brass. To fit the brass it is placed upon a mandrel in a lathe and turned to fit the hole in the driving box; the ends are then slotted up — sometimes of a circular form, sometimes of a form so that if a straight edge were placed upon them it would not touch *all* along the edges. Sometimes these edges are made of a dovetailed form, so that when the brass is pushed in it will have a tendency to spread the brass out. The difficulty I find with all these methods is that however carefully the brasses may be fitted and placed in the casting the casting is spread open, so that when the brass is bored the casting closes in. After the casting is all fitted up and the driving box is ready to be placed on the axle it has closed in, in some cases I have found a thirty-second of an inch. The brass, when new, is from an inch to an inch and a quarter in thickness, and as that wears down the box keeps closing in; and taking out driving boxes from under an engine that has run three to three and a half years I have seen the box come together very nearly a sixteenth of an inch. The result of all this is that when the casting closes it makes a bad fit in the jaws and causes a very disagreeable pounding, and is very detrimental to the working of the engine. I understand that upon some roads a composition driving box has been used, for instance, on the Pennsylvania Railroad, where the driving box is made of solid composition, and is bored at first and fitted to the axle; after it has run and lost motion accumulates, the driving box is slotted out and two pieces of composi-

tion are dovetailed in on either side of the crown of the box; the space between is filled with Babbitt metal, that is bored out and the box is riveted and planed off upon the outside Now it strikes me that this is a much better method than the ordinary style of cast-iron box. On some of the best engines I have seen in this country the flanges on these driving boxes have been broken off, so that shoulders are worn upon the flanges and shoes, and the result is that the lateral motion accumulates to a dangerous extent in some cases. It strikes me that the composition box, aside from the cost, is much the best. I would like to hear the experience of some who have used both kinds, in order that we may arrive at a conclusion as to whose is the best.

Mr. DURGIN, Rhode Island Locomotive Works—I would like to ask the gentleman if that is the usual way the Pennsylvania Railroad takes up the lost motion in the box. I have never seen it done so on that road; but I have seen them put them in under a steam hammer and take up lost motion by putting in new wedges, and I am told, by the foreman of one of their shops, that that is the regular practice.

Mr. LYNE, American Machinist—I did not mean that remark to apply particularly to the Pennsylvania road. I know that thing is done on some other roads. I have done it myself, and with very good results, on slow running engines. I understand that the Pennsylvania road have used those composition boxes with success, and that they are pleased with them; and I would like to know whether their advantages would warrant their use when the first cost is considered.

Mr. SETCHEL, Kentucky Central Railroad—Some of the members will remember that we had a committee on this subject several years ago, and I think Mr. Boon was the chairman. Full report was made at the time, and is published in one of our annual reports, which ought to give us considerable information on the subject.

The following question was submitted by Mr. Fry, of the New York, West Shore & Buffalo Railroad: Is Cast Iron a Safe Metal for Links and Link Blocks?

Mr. FRY, New York, West Shore & Buffalo Railroad—There are a great many gentlemen present who use cast iron for links, which is a much cheaper metal than we are now using, and I want to know if it is a safe metal? Have they ever known any links to break that were made of that material?

THE PRESIDENT—I want to make a speech on that subject. It is safe.

Mr. WILDER, New York, Lake Erie & Western Railroad—I would say that it has been our practice, for the last eight or nine years, to use cast iron for blocks entirely, and for the past two years we have been using a cast-iron link, and for about a year past we have been making links of cast iron and chilling the inside face, and so far I have never known a link to break, and I find the wear is very much better than with wrought-iron links, casehardened.

Mr. PRESCOTT, Pittsburgh, Cincinnati & St. Louis Railroad—I would like to hear from Mr. Paxson, of the Reading Railroad. I think he has used both kinds for some time.

Mr. PAXSON, Reading Railroad—I do not know whether it is proper for me to say anything; I am not a member of the Association, unfortunately; but since I have been called upon, I may say that we have a class of engines which we call, I think, Class E, with chilled faces and cast-iron blocks. We have never had any trouble with them whatever; breakages that we have had, I think, would have occurred with the wrought-iron link. They have never given us any trouble at all; but we are using them on only one class of engines.

Mr. SEDGLEY, Lake Shore & Michigan Southern Railroad—I would like to ask Mr. Wilder what class of engines he uses the cast-iron link on, and if he makes them heavier than he formerly made the wrought iron?

Mr. WILDER, New York, Lake Erie & Western Railroad—I will say that we make the cast-iron link to take the place of the wrought-iron link in every way. We use them on all classes of our engines wherever we are building new ones; I have put them in Consolidation engines. I have put them in two new Mogul passenger engines which I have built; and in all cases where we have put in new links we have put them in of cast iron.

Mr. RICHARDS, Boston & Providence Railroad—We have used cast-iron links for twenty-eight years on a good many of our engines, and I never yet had one fail excepting where some other part broke first. We make them very little heavier than wrought iron. When the locomotives are thrown away the links are sometimes used for another engine.

THE PRESIDENT—The evidence seems to be all one way. I have no doubt from what has been presented, and from my own experience, that cast-iron links fitted with cast-iron blocks are perfectly practicable to be used for our locomotives.

Mr. WOODCOCK, Central Railroad of New Jersey—I would like to ask whether these links are made of the skeleton pattern or are solid links?

THE PRESIDENT—Either way.

Mr. WILDER, New York, Lake Erie & Western Railroad—I would say further in regard to the cast-iron link, that the wear is very much less than it is upon any wrought-iron link we have had. I have put up engines with cast-iron links and blocks on one side, and wrought iron in the ordinary way on the other, and after two years' wear there would be a perceptible amount of lost motion in the wrought-iron block and link, while the cast-iron links did not need repairs of any kind.

THE PRESIDENT—Those of you who were present at our Providence meeting last year, will no doubt remember that Mr. Forney presented a paper to the Association on Safety Attachments for Boilers, advocating the idea of getting fewer holes in the boiler head, and also providing some means whereby the escape of steam and water could be stopped in the event of collision, in

case some of the attachments should be broken, and the lives of the men operating the engine be saved; Mr. Johann, most of you may have seen in the Railroad Gazette, designed something looking in that direction—an inwardly opening valve so arranged that when the fittings break off, that valve will close; the steam will close it. That was a step in the right direction. Mr. Powell, Mechanical Engineer of Concord, New Hampshire, who is employed with me, has designed a steam gauge stand with injector cocks, steam gauge cock, blow cock, brake valve cock and oil cocks, all centered in one casting. He has prepared a short paper which, with the unanimous consent of the Convention, I would be pleased to have him read. If there is no objection on the part of any one I would call upon him at this time to read his paper.

Mr. Powell then read his paper.

Safety Attachments to Locomotive Boilers.

To the American Railway Master Mechanics' Association:

GENTLEMEN—There are many problems affecting the safety of modern railroad traffic which still await solution, and concerning which we are painfully in the dark. Many difficulties have already been faced, and scientific truths extracted from perfect labyrinths of practice and experience by patient persistent plodding. Others are in a semi-transition state, the task of reform but partially completed.

To this latter class belongs the problem of rendering more secure and less liable to injury, by collision or when an engine runs off the track, the numerous attachments to the locomotive boilers. To effect this successfully it seems desirable to reduce the number of openings into the boiler to a minimum, and to provide such openings, when feasable, with a valve opening into the boiler. This valve could close by the pressure of steam in the boiler if an attachment gets knocked off, thus preventing the escape of steam and lessening, very materially, the terrible pain and torture so frequently inflicted.

Mr. M. N. Forney's paper on "Attachments to Locomotive Boilers," published in last year's report of this Association, made a strong and touching appeal for light in this direction—it should serve as a fog signal until we can see our way more clearly to avoid the known defects and danger of our present construction.

The most popular method of reducing the number of openings into the locomotive boiler, for steam purposes, is to convert the steam

gauge stand into a steam chamber and use this for supplying several attachments, while but one opening into the boiler is necessary.

This plan, of course, has some advantages, but the attachments, together with the stand itself, are each subject to injury. I do not think that inventors or designers have usually aimed at making this stand secure in case of accident, their efforts have rather tended towards display and elaborateness, until the primitive stand, a small casting for holding the steam gauge, assumes proportions which are frequently imposing. To Mr. Jacob Johann first belongs the honor of making public a steam gauge stand provided with a safety valve opening into the boiler which closes when an accident breaks off the stand. I have taken the liberty of incorporating this invention in the drawings of a steam gauge stand accompanying this paper. It is a difficult matter to so design a stand, intended to receive boiler attachments, that it will, when completed, be compact, easily accessible, readily cleaned and cheaply manufactured. The injector valves are usually a great source of trouble, and, to save complication and appearances, are frequently screwed into the boiler direct. When made an appendage to the stand, the ordinary form of valve requires such alteration as will make it convenient for the engineman to handle without removing the injector pipes from the neighborhood of the boiler.

It is very trying to step into a locomotive cab and see injector pipes running in a variety of sinuous courses, or note the boiler attachments located without regard to mechanical precision, scattered here and there wherever the workman happened at the time. I I would suggest attaching the injector valves by a **T** pipe to the back of the stand, and giving them parallel sides and rectangular corners so they may be finished cheaply; also, placing the injectors on line with the valves so that the pipes could be curved concentrically with the crown sheet of the boiler. The **T** pipe forms a convenient place to attach the steam gauge syphon; and if thought desirable, in order to still farther reduce the number of openings in the boiler, the whistle pipe could also be attached there. In this case the whistle would require to be placed over the cab, with a globe valve between it and the **T** pipe to be used in case the whistle only gets knocked off. The handles for operating the cylinder oil-

ing cups, the blower valve, the valve for Westinghouse pump, and the cam which controls the safty valve opening into the boiler, all face the engineman, and are equidistant from the stand. The steam gauge stand has parallel sides and rectangular corners, so that it may be finished as much as possible by machinery, and is held to the boiler by four studs. It seats in a quarter turn attached to pipe running forward into the dome. Just above the flange and below the steel cam and spindle, the stand is weakened by cutting a light groove all around it. Here the stand will be likely to break when the injury is sufficiently severe, and the valve opening into the boiler, released from the control of the cam, is instantly closed by the steam pressure on the boiler.

To the drawing of the steam gauge stand I have added one of a safety check valve, which is designed to sit in its ordinary position on either side of the barrel of the boiler. The valve casing is attached to the boiler by a stout flange and studs; the steel pin, which is let in from the top of this flange, allows the safety valve opening into the boiler and seated on the casting to travel back and forth so as to form no impediment to the ingress of water to the boiler.

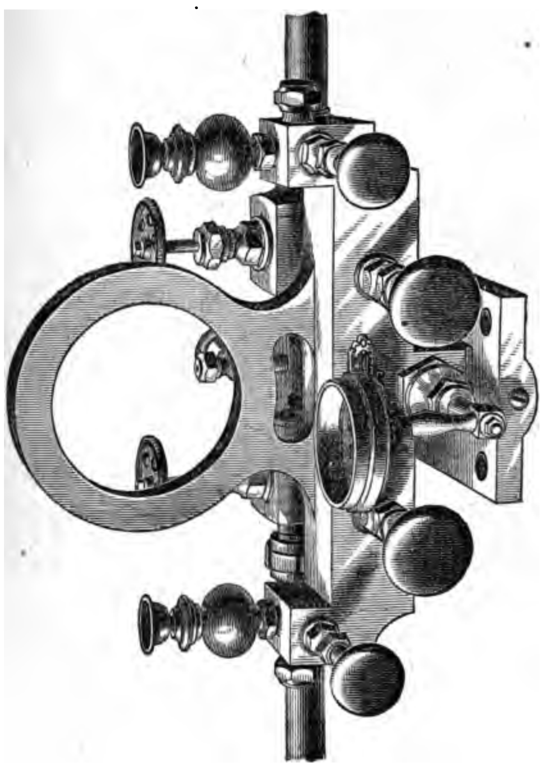
A groove is cut all around the neck of casing close to the flange, here a fracture will take place in case of sufficient injury, leaving the safety valve securely seated inside the boiler. By using this arrangement engine drivers will be enabled to examine and grind check valves when the boiler is under steam pressure. A small cock could be attached to the bottom of the neck for the purpose of removing any water that might be present. When the safety valve requires examining, the entire casing may readily be removed without disturbing the lagging by adopting the plan shown in the drawing. It will be seen that the ten attachments most liable to injury in a collision, or when an engine runs off the track, have been given but three openings into the boiler, and each of the three provided with a safety valve, simple in design, instantaneous in its action, and which does not interfere with the practical working of the attachments.

I earnestly trust that the problem of preventing accidents to persons by the escape of steam from locomotive boilers may soon be

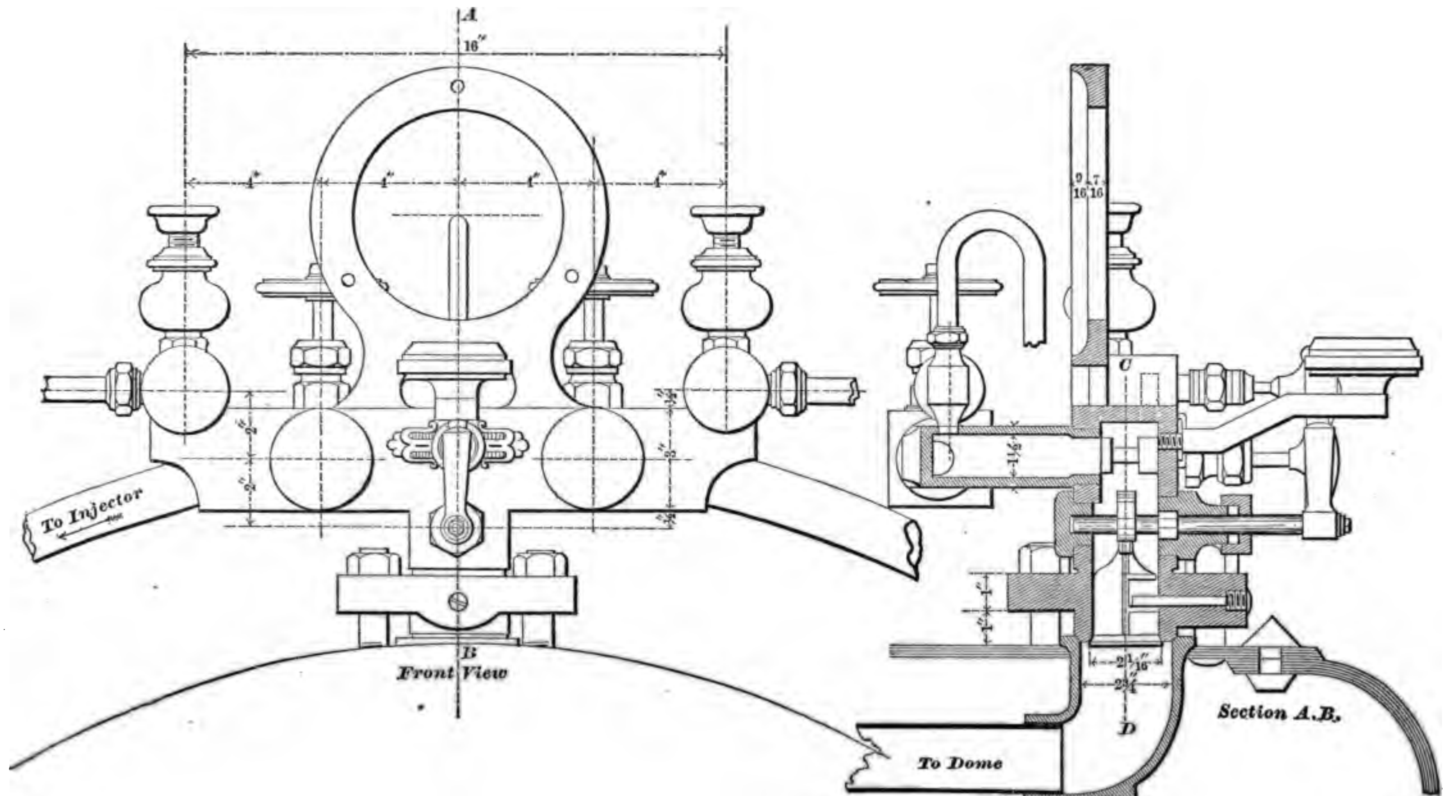
l; and that the accounts of their terrible and appalling results, so frequently in our newspapers, may become a thing of the

BERKELEY POWELL.

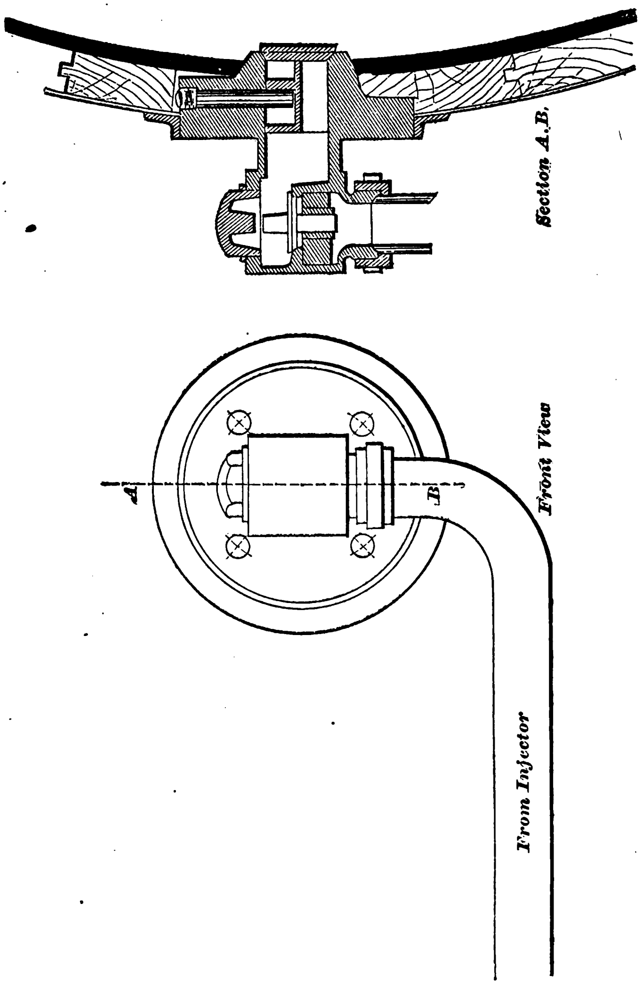
PRESIDENT—I would say that our Secretary has posted upon the n board a blue print of the steam gauge and other attachments men- in the paper. Those of you who would like to examine it can do so r leisure.



Steam Gauge Stand with Accompaniments.



Steam Gauge Stand Attached to a Boiler.



Safety Check Valve.

Mr. Woodcock, Central Railroad of New Jersey—I move that the paper be received and incorporated in the minutes.

The motion was carried.

A recess of five minutes was taken to enable members to examine the drawings accompanying Mr. Powell's paper.

Mr. Hollister, Savannah, Florida & Western Railroad—I simply want to say that I have given a little attention to this matter. I designed for my own use simply a stand to perform the same purpose that that does. It has a valve closing upward, with a screw stem running down, and the valve is opened by drawing down the stem. The disposition of the metal in the stand is such that they break off in case of accident just below the valve stem.

Mr. Fry, New York, West Shore & Buffalo Railroad—I would like to propose that Mr. Hollister, or other members of the Association who have devised means of meeting the question that Mr. Forney raised, the possibility of applying steam to its various uses without making the boiler openings fatal to life if cocks are broken off, should send blue prints to the Secretary of the Association, so that engravings might be made and incorporated in the report. I suppose that an engraving of the device before us will be published in the report; but if we can have some other devices showing that the members of this Association are moving in the direction which the public seems to be calling for, it would be a good thing.

Mr. Setchel, Kentucky Central Railroad—If the gentleman's suggestion would make it necessary that *all* such prints sent should be engraved for publication I should be disposed to object to it, because it might be very expensive. I would want to leave it to the discretion of somebody as to whether they were valuable enough to be engraved; single engravings might be sent that would cost twenty-five or thirty dollars.

Mr. Fry, New York, West Shore & Buffalo Railroad—I should be glad to modify my suggestion in view of what Mr. Setchel has said, and I would move that the drawings which may be sent to the Secretary be referred to the Supervisory Committee.

Mr. Johann, Wabash, St. Louis & Pacific Railroad—I simply wish to say that I consider that device very good. I have used something similar to that for four or five years; I do not know exactly the time. I hesitated for some time before entering into it, but we finally made a valve and constructed the attachments in such a way that in case of accident it will break at a certain point, which is made the weakest part of it. In the case of a rear collision, where the caboose got on top of the engine, and took the cab off, and took this stand with it, the valve acted so instantaneously that there was no disfigurement of the boiler head from steam or water. I merely wish to say that if it be properly constructed the engineer will be protected.

The motion was carried.

The Convention then adjourned till 2:30 P. M.

AFTERNOON SESSION.

THE PRESIDENT—If any members of the Association have subjects that they wish to present to the Committee for their consideration, to be acted upon the coming year, it would be desirable to have them presented some time during the day, as the Committee would like to meet to-night to consider the matter. The next business in order is discussion of the paper read by Mr. Joy. That gentleman is present, and will undoubtedly be glad to answer any questions that may be asked him in regard to his valve gear; and I would like to have the members give this matter their best attention, and not be backward in asking Mr. Joy any thing they may desire.

Mr. HAYES, Illinois Central Railroad—I would like to ask Mr. Joy one or two questions. It is customary with us Americans when we make a new departure to know what advantages are to be gained by it, and the change from the link motion to this gear—the motion of which is taken from the connecting rod—is certainly a radical change. When we changed from the pump to the injector, we found out the advantages of the injector before we adopted it. I know I made a number of tests on our road, and found the advantages were seven per cent. gain in fuel, and also that the engine would carry steam more regularly. Now I would like to know whether there is a saving in fuel, and whether an engine will do more work with the Joy valve gear than with the link motion?

Mr. JOY—Mr. Hayes has kindly given me an opportunity by answering his question of stating what I think are the advantages to be gained by this gear, and I will try to state them as shortly as I can: First, The change involves very little alteration, indeed, of your engine. I have laid it out so that this gear can be adapted to any existing engine, simply by clearing away the eccentrics and attaching to the slide bar a bracket to carrry my gear, so that you can really take any one of the existing engines and adapt this gear thereto for simply the cost of the gear. Mr. Hayes' next question was whether any saving in fuel resulted. Well, we have not yet made any experiments in this direction. The first engine has been running about a couple of years, and we know from our experience of that that we have got a more perfect valve gear, and, other circumstances being equal, we ought to make a saving of fuel. My chief object, however, in arranging this gear was to make other savings. In England, with a good runner, the consumption of coal is already pulled down nearly as close as it can be. My gear is less costly. That is the question the purchaser always asks first. In marine engine work especially (for which I may say I originally designed this gear) the first question put is: "Will it cost more?" Well, I can positively say that it will cost less for such engines, probably

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thirty per cent. In your engines the saving will be a great deal more, because we save the weigh-bar shaft and levers in addition. I have already explained that I can give a perfect cut off forwards and backwards, and at all points of cut off, and it gives a sharper admission and a sharper cut off for the steam. Now I believe most of you admit that a tappet valve, or any valve which suddenly opens and suddenly cuts off the steam, is the best valve to employ to admit and cut off steam; with this valve gear I approach to the action of the tappet-valve gear. But I have no jerks and no jumps. This arises from the fact that the motion given to a valve with lap and lead consists of two distinct parts—the one part being that portion of the throw which draws the lap and the lead, the other portion being the amount of opening given to the port. Now, by my gear, each of these parts of the motion is given by the functions of different parts of the machinery, and so may be controlled and proportioned separately respectively; the lap and lead are opened by the lever action of the valve lever, the port is given by the incline of the curved slide in which the centre of that lever slides, and depends on the angle given to that incline. It follows that when these two actions are in unison, the action of the valve is very smart, and this occurs when steam is being admitted. There then follows a period of opposition of these motions, and the valve almost dwells, as this corresponds to the moment when the valve is fully open. A further period of unison follows, and this gives the smart cut off. Now the gear is all outside of the engine, and can be touched when standing alongside without any reaching over the inside, or from the running board. Further, it leaves the more room under the boiler, because, by clearing away the eccentrics, you can bring the fire-box closer up to the driving shaft, and you can put in ten or twelve inches additional fire box between the same frames than with the eccentrics, for which room ordinarily has to be left. Again, it never needs reversing. We know quite well that when the lever for a link motion is pushed over to the far end of the quadrant, and you have got to the bottom of the link, you can not go any further. If the engine will not start, then you have to back her. With this gear I always leave a blank place with a spring, preventing your going into that part unless you need it, so that if the engine will not start when the lever is at its furthest notch, it is only necessary to push the lever further over into the blank space to get .80 to .90 per cent. cut off, and the engine will always start with .90 per cent. Again, it has considerably less compression than with the link gear when cutting off with 25 per cent. length of the stroke. With the link gear, and the ordinary lap of an inch, you begin to compress at .46 of the stroke; with the Joy gear you only begin at .30 with the same valve and the same lap. If, however, this compression is not considered sufficient for fast running engines, it is only necessary to add a little lap on the exhaust side of the valve to get any required compression; and, in doing this, another advantage is gained at the same time, the steam is held

ger in the cylinder for expansion. These are really the important ad-
tages that I think of at the moment, and this, I hope, will be satisfactory
Mr. Hayes. There are, however, other and minor points which will be
nd in working out the gear.

THE PRESIDENT—Did I understand Mr. Joy to say that he had no com-
ative statements of the consumption of fuel?

Mr. JOY—We have not had any taken. The engine is of a larger type
n any other on the London & Northwestern, and, therefore, there was
hing to compare it with; but very shortly, when we get a lot of engines,
shall get comparative statements, not that I look for a large saving in
l consumption, because, in England, as I said before, I think we have
led down the consumption of fuel about as low as possible, and any thing
can gain by a more perfect valve motion will be only a very small deci-
l; but the advantages quoted are all of a practical kind, and such as
be at once appreciated by the members.

Mr. WILDER, New York, Lake Erie & Western Railroad—I believe that
Secretary has with him a chart which was sent to him by our worthy
ce-President, Mr. Reuben Wells, showing a diagram of the action of the
ne valve with the Joy valve gear and with the link gear, and I suggest
it the Secretary should post up that diagram and explain it to the Asso-
tion—the difference in the point of cut off and the amount of opening,
d all those points shown on the diagram.

THE PRESIDENT—I don't suppose Mr. Wells prepared those diagrams
d sent them here for the purpose of antagonizing the Joy valve gear in
y way; but simply that they are some diagrams that he has worked up
show the difference in the distribution of steam between the link motion
d the Joy valve year. I have examined this diagram, and I think it
ows very plainly, in fact it absolutely shows, that the two valve gears,
e Joy and the link, are both very perfect. You will notice, perhaps, in
amining it (as Mr. Setchel will explain to you) some few points where
ey vary, but generally they run very close. The Joy valve gear, how-
er, holds on to the steam somewhat longer when linked up.

Mr. WILDER, New York, Lake Erie & Western Railroad—It was not
th any intention of antagonizing the Joy valve gear that I called this mat-
up. I did it because I have been looking over this diagram of Mr.
ells, and I was struck with the closeness with which the lines of both
ars follow each other, and I had a wish to explain that I had already,
m drawings that have been sent to me by Mr. Wayland Turner, the
presentative of Mr. Joy in this country, made a half-sized model of the
ar, and had been struck by the peculiar and different action of it, but I
d not taken the precaution of comparing it with the link motion in the
y Mr. Wells has done, and that is why I called for the paper, that the
art may be brought out before the Association.

Mr. SETCHEL, Kentucky Central Railroad—In order to have this chart

understood it is necessary for the members to get close enough to it to see the lines clearly in order to understand it.

The diagram shows the movement of the valve at five different points of cut off in the stroke of 24 inches when worked by the Joy gear, and also by the link, both motions being plotted on the same space. The full line ——— showing the Joy movement, and the dotted line - - - - - the link movement. The valve and steam ports and length of connecting rod was the same in both cases; and the differences in the movement of the valve, as shown by the lines of motion on the diagram, is due to the system from which the valve obtained its motion.

In the Joy system the valve obtains its motion mainly from the vertical movement of the connecting rod, consequently a vertical movement of the axle in the pedestals will affect the point of cut off, either hastening or retarding it, as the case may be. The effect of the engine settling on the driving springs so that the centre of the axle would be one inch above its true position relative to the frame, or of raising the engine on the springs so that the axle would be one inch below that point, is shown in the diagram by the line with the round dots —○—○—○—○—○— and the line with crosses + + + + +. When cutting off at 20 inches of the stroke, by the Joy gear, with the axle in its true position, the valve has the motion shown by the full line ———; by displacing the axle to a point one inch higher up in the frame of the engine, the valve will have the motion as shown by the round dotted line —○—○—○—○—○—, and by moving the axle downward in the pedestals to a point one inch below its true position, the valve will have a motion as represented by the line with the crosses + + + + +.

The lower straight line, A B, represents the edge of the steam port, and the distance from A to C ($1\frac{1}{4}$ inches), on the upper line, represents the width of the steam port The lead of the valve for the Joy gear was $\frac{1}{16}$ inches, and for the link at full stroke it was 0, or line and line.

The explanations given in the diagram will enable those who examine it closely to readily understand it. It will be noticed that the difference in the movement of the valve by these two systems of motion is very slight, that the lines are parallel with each other at nearly all points. In some parts the Joy gear gives the best motion, and in others the link. In closing the port, the valve, as it approaches to the point of cut off, has precisely the same motion in both, the lines in all cases being parallel; the Joy motion showing no advantage over the link in causing the valve to move more rapidly when nearing the point of cut off.

The exhaust lines, which are shown below the line A. B, are also parallel with each other, the only difference being that the Joy gear holds on to the steam, exhausting a little later than with the link at the earlier points of cut off, as will be noticed in the diagram. With the Joy gear the points at which compression begins is a little nearer the end of the stroke, and consequently

there is a little less compression when cutting off early in the stroke than with the link motion. yet this difference is comparatively small. At and near the full stroke the link shows least compression. The vertical movement, or displacement of the axle from its correct position to the extent of one inch above and below that point, affects the area of the steam opening given and point of cut off, at all points, as will be seen by the distance between the heavy line and the round dotted and the crossed + + + + + lines above and below it—the round dotted line being above on the stroke of piston from the back end, and below on the stroke from the front end of the cylinder. The curved, heavy and dotted lines near each end of the stroke, and below the steam port line A B, as I said before, represent the exhaust opening as the piston approaches the end of its stroke, and show the point at which the exhaust begins, and the extent or area of the opening when the piston has completed its stroke.

Mr. Fry, New York, West Shore & Buffalo Railroad—I should like to call attention to one very important advantage which would be given to us by the use of the Joy valve gear, and that is the opportunity it affords for the extension of the fire box. Those who have recently been called upon to design locomotives for very heavy traffic, especially passenger locomotives, have been met with the difficulty of getting a sufficiently large fire box, especially in the case of engines burning bituminous coal. With anthracite fuel it has been possible to extend the fire box over the top of the frame, and in most of the recent engines for heavy traffic this has been done; but with bituminous coal it can not so well be done, as the fire box is then too shallow; and if you put the fire box between the driving axles you are at once met with the difficulty of the great length of side rod necessary to get a sufficiently large fire box. But with the Joy valve gear, doing away as you do with the eccentrics, etc., a considerable extension is permitted of the fire box, which, it seems to me, is a very valuable feature, and one that should not be lost sight of; and if it can only be shown that the Joy valve gear is, at least, as good as the old eccentric motion, this advantage of the fire box is a pretty decided advantage which the Joy gear possesses over the old motion.

Mr. Joy—Mr. President and gentlemen: I am very much obliged to the gentleman who has just spoken (Mr. Fry) for giving more weight to that question of the facility allowed by my gear for an increased length of fire box than I had given myself. That is a phase of the matter that has not so prominently presented itself to us on the other side as it seems to have done to you—probably because you are drawing heavier loads than we are. For the sake of argument I am quite willing to admit, for the moment, that even if my gear is only as good as the link gear, though from the explanation I have already given of its action I think I prove that it is better; yet the col-

lateral advantages given, such as the one Mr. Fry refers to, give it such a preference as to commend it to your very practical attention.

Mr. SETCHEL, Kentucky Central Railroad—I quite agree with Mr. Fry in regard to the advantage of legthening the fire box. I think that if we can make our fire boxes long enough so as to give more grate surface and give the flames an opportunity to consume the gases before they enter the tubes, that we would get much better results from our locomotives. Beyond all question a short fire box has been in the way of an economical consumption of fuel because we could not get grate surface enough without making our engines too heavy and our boilers too large. We have been able to make combustion slow enough to give time to consume the gases before they enter the flues; and I think, as Mr. Fry has said, that admitting that the Joy gear is equal in durability and in point of economy in working the steam to the eccentric motion, that the advantage gained by means of the adoption of the Joy valve gear, in lengthening the fire box, is certainly a step in the right direction.

THE PRESIDENT—I look upon it as a singular fact that a valve gear should be designed, so radically different from the ordinary recognized valve gear for locomotives (namely the eccentric link motion), that would so nearly give the same results as one obtained with the link motion. I am very much gratified that Mr. Wells prepared this set of diagrams, showing the same lines as drawn from the two valve gears. That diagram will bear a good deal of study, and I hope it will be incorporated in our next report. That diagram shows very little advantage one over the other, especially in the admission. It is marvelous that the admission and the points of cut off should run so nearly parallel with each other—at some points the Joy gear a trifle ahead at other points the link gear a trifle ahead. In the matter of exhaust the Joy gear is manifestly ahead working at short cut offs—working at .25 cut off or at .75 cut off—say at 6 inches the Joy gear holds on to the steam an inch longer than the link does; that, I think, gives the Joy gear, working short, the advantage. I should like to hear from some of our members in regard to this matter, for it is one that will be studied a great deal in the coming year, Perhaps some of them may prefer to wait until it is studied before they commit themselves to its use, though that is hardly the way to progress, for one to wait for another.

Mr. WILDER, New York, Lake Erie & Western Railroad—In a letter, accompanying the diagram, Mr. Wells stated the amount of the lap and also the travel of the valve in the case of the link motion and that of the Joy gear to be the same; but I don't remember what it was at this moment.

Mr. SETCHEL, Kentucky Central Railroad—The same valve was used in both cases, that is, a valve of the same dimensions. The lead of the valve in the Joy gear was $\frac{3}{16}$ inches, and for the link, line and line.

Mr. WILDER, New York, Lake Erie & Western Railroad—As I under-

stand Mr. Fry and several other gentlemen, after looking into the matter in a sort of off-hand way, went to Reading, Pa., last week and examined this gear as applied to an engine on the Philadelphia & Reading Railroad, and there they found, on actual trial, that to get the full beneficial results of the Joy valve gear it was necessary to have a shorter lap, and advised using the Allen valve to get a double admission of steam; and I understood Mr. Paxson, the chief of the machinery department of the Reading road, to say, to-day, that he had heard, by telegram, from Mr. Wooten, the general manager, that the engine (which was in the shop at the time of Mr. Fry and the other gentlemen's visit) had been since tried with a very heavy train—one of their excursion trains in fact—and that in its performance it was equal, in every way, to what they had got at any time from the link motion.

Mr. Joy—May I add a remark here, or perhaps I should say a caution, and that is this, that with the link gear we are all as familiar as with our alphabet; we know exactly how to fix it and how to get the centres, and you have got it, in fact, as near perfection as a link gear can be made, and have exhausted its capabilities, whereas my gear is new to you. I am free to admit that I have never seen more perfect steam diagrams, from the link motion, than are here given by Mr. Wells, of the Louisville & Nashville Standard, indeed they surprise me. So far as my own gear is concerned, I claim that I get as nearly as it is possible to do a systematically correct movement of the valve; I get, unquestionably, a more rapid opening and a more rapid cut off than the link gear can possibly give. But I can not expect that the advantages obtainable from my gear can be instantaneously realized by any one. It can only come from experience. In going around, during the last fortnight, through many machine shops, I have noticed that the very best has been made out of the link motion that can be made; I have, in fact, seen refinements of it here that I have never witnessed in England; whether or not you are driven to this by the hard work your engines have to do I know not—probably that is so. But I again ask you to remember that my gear is a new gear. I can not expect any of you to realize its capabilities and to secure its maximum advantages instantly, I was not able to do so myself. I am sure that if I had had an opportunity, in conjunction with Mr. Wells, of showing how my gear would work in comparison with his Louisville & Nashville Standard link gear, I could have honestly proved to him and you that the action of my gear is far superior to that of the link. I have not had the pleasure of meeting Mr. Wells; but I am sure, by the way he has handled the matter, that he must be a very able gentleman; but I say again I can not expect him to be in a position to make the best of my gear, as, from his remarkable diagram, he must be able to do with the link. I have worked at my gear for 12 years or more, and been learning all the time; I have got it on inside and outside cylinder locomotives, marine engines, steam plows, rolling mill engines, in fact, in engines for all kinds of purposes with most successful results; therefore I ask you to give it a few

months' trial; get to understand it and to handle it to some extent, as well as you handle the link, and then let us see whether you can't make it come out ahead. To quote the remarks made by the well-known European mechanical authority, Dr. Siemens, at the British Mechanical Engineers' Meeting, two years ago, when the engine with my gear, a photograph of which I now produce, was exhibited at Barrow: "I think," said Dr. Siemens, "that the link motion is doomed, and that we shall have something like this Joy gear in place of it." I quote Dr. Siemens because he is well known to be a very high authority and impartial. I once more ask you to kindly remember how well you know how to get the best out of the link gear of which it is capable, and, on the other hand, how little you may yet realize what can be done with mine. By the courtesy of Mr. Paxson, I shall be enabled, within a few days, to take indicator diagrams from this engine, and which will be at the service of the Association. Mr. Paxson will furnish them. In conclusion, I feel, a word is due from me to yourselves and your magnificent country. I came here as a stranger, but I don't seem to be a stranger now; from the moment I set my foot on this side I have received such courtesy and kindness that I can not refrain from expressing my most sincere thanks therefor, and for the fair way in which my valve gear has been discussed. I am sure that nothing that has been said has been meant to be antagonistic; and I shall be very glad, indeed, to be at your service hereafter in giving any explanations which may be desired in regard to the Joy valve gear.

Mr. Setchel, Kentucky Central Railroad—I move that the discussion of this subject be closed, and that a vote of thanks be tendered to Mr. Joy for the paper which he has read before the Convention.

Agreed to.

The President—The first business before the meeting will be the reading of the report of the Committee on Best Material and Form of Construction for Parallel Rods of Locomotives to Prevent their Breaking, presented by Mr. Howard Fry.

Mr. Fry, New York, West Shore & Buffalo Railroad—I would say, gentlemen, before reading this report, in common with a great other many members of the Association who have to prepare reports, I found myself very busy, having a great number of things to attend to, and I kept putting it off from time to time, wondering if some excuse would not present itself for not preparing the report. There is sometimes the excuse given, for not preparing a report, that members do not respond to the letters sent to them; but the great kindness of the members this year, or the great interest taken in the subject, did not give me that excuse; and, finally, finding that some report had to be prepared and that I could not do it myself, I thought of the plan of delegating my duties to some one; and I think, gentlemen, you are to be congratulated that I did not prepare this report, but that a young engineer in my office, Mr. Worthington, undertook that duty for me; and I should like to say, right here, that there is a growing tendency in our offices to re-

ain the services of educated engineers who have passed through the shops and who have the enthusiasm and the time at their disposal to devote attention to specialties in locomotive construction. We have already received one or two reports of this kind in this Association, and I hope, in the future, we shall receive a good many more.

Mr. Fry then read the report.

Report on Side Rods for the Master Mechanics' Convention.

To the American Railway Master Mechanics' Association:

Side rods have very commonly been considered one of the necessary evils in locomotive construction since the time when the earliest engineers discovered that the tractive force of one pair of wheels was not sufficient to haul heavy trains.

Efforts have been made to abolish them altogether, notably in Mr. Webb's compound locomotive, where the cylinders are arranged to work on two different axles; also in Mr. Strong's driver coupling, which, by lengthening piston rod and guide bars some eight feet, enables him to place two connecting rods to each cylinder; and the new Fontaine engine, in which the upper wheel drives two lower ones by friction. But as it is not certain that these efforts will revolutionize ordinary practice, it is important to ascertain what is the best form of side rod to adopt.

Fifty years of practice have brought into use a great number of designs, and accompanying this report is a series of sketches illustrating the variety of them.

The duty of a side rod is to transmit a rotary motion from the main driving axle to other parallel axles. To do this it must be stiff enough to transmit a thrust along its length without buckling; at high speeds it must be sufficiently strong to resist its own momentum; it must also have ends forming good bearing surfaces.

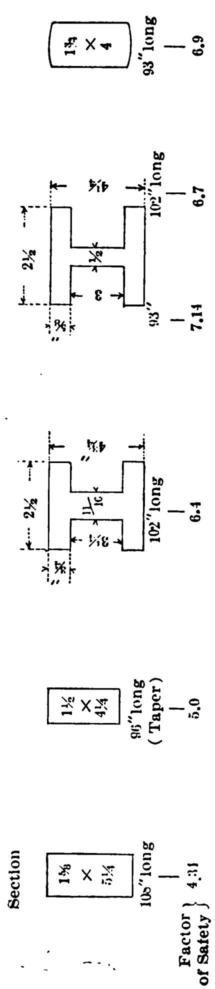
The first of these is amply satisfied by every section in use, as rods have to resist greater strains than this. As to the second, however, it is curious to notice in the history of coupling rods the gropings of engineers after a section of rod which is at the same time light, cheap, and rigid, especially in a vertical direction.

There are many rods still running of a circular section throughout; these are cheap of manufacture, but being of the same rigidity, both vertically and horizontally, they are disproportioned.

This was somewhat improved upon by making rods of elliptical section, but this was too expensive for a finished rod.

Again, a favorite way with some builders of heavy freight engines is to make their rods thick as well as deep rectangular bars. This is when the engine is not expected to run fast.

Passing from this we find the ordinary proportion of rod to be about one and one-half inches multiplied by four inches, see Figs. 1, 2, 3, etc.; and at the opposite extreme we have on a great many railroads a rod with the middle section of about $1\frac{1}{4}$ by 5 inches, that is, four times as deep as broad. See Figs. 6, 14, and 16.



Several attempts have been made of late years to find a lighter section of rod which will at the same time be stiff and cheap.

In Germany, and also in this country, an I beam section of rod has been used. See Fig. 4. The finished section of this rod will be found to be lighter than the ordinary rectangular section, the strength being mainly in the top and bottom flanges. See Figs. 4, 10, 13, 15, and 18.

And this section leads to a rod which is worthy of more consideration than it has hitherto received, see Fig. 17; simply two round bars of iron connected at the ends by brass castings. These rods have been used on switch engines, and have given satisfaction.

In comparing a few of these sections as to their ability to resist their own momentum in a vertical direction, taking account of the length of rod, and considering the point in their path where the vertical accelerating force is greatest, and allowing the engine to be running about 60 miles an hour, it will be found that in—see cut.

It is interesting to note that, for resisting these strains the heaviest section here shown is the weakest, thus proving that the metal has been wrongly distributed. Owing to the impossibility of calculating the extraordinary strains

which are thrown on side rods, in bad weather, in sanding, and when the tires are in bad condition, or by a careless engineer, the factor of safety should be tolerably high.

One of the strongest of these sections, shown in Figs. 5 and 20, has only 20 inches throw. It is used for express, tank, and Good's engines, and has never failed through its own weakness since its introduction in 1871. It will be noticed that the top and bottom edges are turned in a lathe, which some engineers object to on the ground that it thus presents a less section where the greatest strain is, and therefore is more apt to start a crack.

There is a curious divergence of practice with regard to the section of rod throughout its length. Uniformity is the usual rule, but a large number of rods increase in depth towards the centre, in some cases as much as one inch. The rod, shown in Fig. 20, thickens in breadth towards the center $\frac{1}{4}$ inches, this being done by planing the rod while in a bent condition, while one excellent rod, Fig. 14, is thinned out in the middle from $1\frac{7}{8}$ inches at the ends to $1\frac{1}{4}$ inches, while, at the same time, its depth is increased from $4\frac{1}{4}$ to 5 inches, thus lessening the section from 8 square inches in the ends to $6\frac{1}{4}$ square inches in the middle, and at the same time keeping the vertical strength the same throughout. This rod is made of steel, and has therefore been left out of the above comparison of strength of sections.

WEIGHT.

A heavy side rod is such an impediment to an engine's rapid progress, that the lighter it can be made the better. A very heavy rod is shown in Fig. 18, weighing 314 pounds. Other weights of manufacturers' standard rods are 302 and 320 pounds. On the other hand, Fig. 4, though but 9 inches shorter, weighs only 170 pounds, and is used for very fast traffic. Between these we have a great variety of weights. The rods of **I** beam section are lighter than those of rectangular for equal strength; but a proper proportion of web to flange has not yet been reached in practice. Comparing Figs. 4 and 19, both **I** beam sections, but whose sectional area, respectively, is $4\frac{3}{4}$ and 6 square inches, and whose weight, being 102 inches long, is 185 and 250 pounds respectively, it appears, as before stated, that the former is stronger than the latter in the proportion of

6.7 to 6.4. The **I** beam section adopted in Germany is shown in Fig. 4.

ROD ENDS.

With regard to rod ends there are three different systems illustrated, Figs. 1, 2 and 4; the type represented by Fig. 1 is that of a strap holding the brasses and secured to the rods by two or three bolts, and pierced by a cotter to take up wear. Another method is to forge the rod ends solid, and to form a wearing surface by inserting either ordinary brasses and cotter, or a solid bush made of brass or white metal. The objections to the former are the great mass of metal required to firmly bolt the strap to the rod; and, secondly, the weakening of the strap by piercing it with bolts and square cotter holes; and, thirdly, the liability of cotters to come loose.

The disadvantages on the other hand put forward against solid ends are, that the wearing surfaces are not adjustable; as there is much to say on each of these methods, we will first consider the strap end.

It will be noticed, at once, that all rods with a strap require a large mass of metal for the strap bolts to pass through, as well as room for a cotter; this has been ingeniously modified in Fig. 6 by placing the cotter between the two bolts, which necessitates, however, slotted bolt holes in the rod end as shown. A more direct way of lightening the end is to cut a large hole in the useless mass of metal.

The weakening of straps by cotter and bolt holes has been so often the cause of the failure of rods, that a comparison of some rods now in use may be interesting.

In a common rod, a strap $2\frac{1}{2}$ inches wide is weakened by a $\frac{3}{4}$ inch cotter and $\frac{7}{8}$ inch bolt.

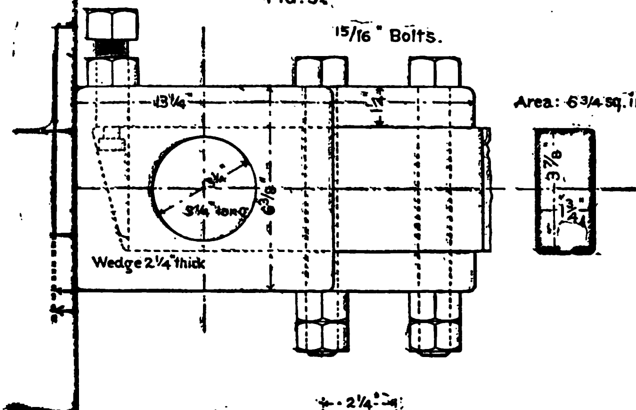
In another rod, a strap $2\frac{1}{8}$ inches wide is weakened by a $\frac{3}{4}$ inch cotter and $\frac{7}{8}$ inch bolt.

In another rod, a strap $2\frac{1}{2}$ inches wide is weakened by a $\frac{7}{8}$ inch cotter and $\frac{7}{8}$ inch bolt.

In Fig. 1 rod, a strap $2\frac{1}{2}$ inches wide is weakened by a $\frac{3}{4}$ inch cotter and 1 inch bolt.

In Fig. 6 rod, a strap $2\frac{1}{2}$ inches wide is weakened by a $\frac{3}{4}$ inch cotter and $1\frac{5}{8}$ inch bolt.

FIG. 3.


15/16" Bolts.
Area: 6 3/4 sq. in.
13 1/4"
Wedge 2 1/4" thick
3 1/4" long
6 3/8"
3 7/8"
2 1/4"

this report. Mr. Stroudley's rod end and section are shown in Fig. 5. Other bushed rods are shown in Fig. 4; Figs. 7 to 10 show practice in Austria and Germany.

The strength of cotters requires consideration, as they are a frequent source of failure; the main point is, to make the cotter not only able to stand its strain without breaking, but to make it so strong that under its working strain it shall never be even deflected, as such a deflection causes a pinching and loosening of brasses. The usual breadth of cotters seems to be $\frac{3}{4}$ of an inch, though we find a $\frac{5}{8}$ inch cotter in a very neat, strong rod, Fig. 12, and a $\frac{7}{8}$ inch cotter in another much used rod; but it is unadvisable to increase this on account of weakening the strap. But its depth might, in many cases, be increased with advantage, e. g. a light but very common section of cotter is $\frac{3}{4}$ by $1\frac{3}{8}$ inches in the middle, while Mr. Stroudley's cotter for a connecting rod, small end, measures 1 by $3\frac{1}{4}$ inches in the middle. In comparing these, though the ordinary working strain on a side rod is only half that on the main rod, the former ought to be as strong, if not stronger, on account of the sudden shocks to which the main rod is not subjected.

Another minor question on this subject of cotters is, whether it is a real disadvantage to place the cotters at both ends of a rod, on the inside, as in Fig. 16. The objection to the above mentioned arrangement is, of course, that any closing of brasses leads to a corresponding lengthening of the centres of the brasses, unless the back of the outside brass be carefully lined up. The disadvantage, on the other hand, of placing the cotter on the outside of one end is a heavier end and less uniformity.

A modification of the strap and cotter, that of a screw adjustable wedge has been neatly applied to side rods in Fig. 3. In the place of the ordinary cotter hole, only the top half of the strap is pierced by a 1 inch set screw with lock nut, which raises or lowers the wedge; the latter having a taper of 1 in 4 at the back of the brass. It would be interesting to know if these wedges with so steep a taper have lasted well or not. And this brings us to the subject of the right taper for cotters.

The variety in use may be gathered from a dozen examples; of cotters secured by a set screw, three have a taper of about $\frac{5}{8}$ of an inch to one foot; four have a taper of about $\frac{3}{4}$ of an inch to one foot;

have a taper of about 1 inch to one foot. We find cotters, red by a screwed end, with tapers of $\frac{5}{8}$ and $\frac{3}{4}$ of an inch to one Mr. Stroudley's cotter has only $\frac{1}{4}$ of an inch taper to one foot. most recent heavy freight engine, on the London & Northwest- Railway, has only two cotters in its whole structure, these being 'e the piston rods are connected to the cross heads, which shows strong feeling against the use of cotters on this railway.

very neat German cotter is shown in Fig. 8, where the cotter is wo pieces, placed one on each side of the rod, and pressing ıst the flanges of the brasses; a bolt through cotters and rod s them tight. The greatest advantage for this end seems to be instead of piercing the rod with a slotted hole the cotter bear- are made by simply planing a step on each side of the rod. 10 shows an ingenious method of adjusting the brasses by a ;e without piercing the solid end by any hole. The drawing ex- ıs itself, and it may be left to each individual to judge of its tical merits.

'ig. 9 also shows one variety of a style very common in German gns, that of dovetailing the block into a forked end and securing ıere by a light bolt through fork and block, a cotter being used, ısual, to close the brasses. With good workmanship this must ı a very fair end, and we are sorry that we lack information as ıe workings of these ingenious devices.

ıme engineers, in Europe, have fitted their brasses into ball s, in order to give the wheels more lateral freedom, but the ı expense and double wearing surface can scarcely compensate ;he very small advantage claimed. The rods of a very heavy t-wheel coupled engine, on the Paris, Lyons & Mediterranean way, shown in Fig. 26, illustrates these ball joints. All the ls are flanged, and in order to get the engine to traverse curves 30 feet radius, 1 inch side play in each direction is allowed in ading and trailing axle boxes, and spherical or ball bearings in de rods were necessary to allow this. There were 90 of these es in successful use in 1880, with cylinders $21\frac{1}{4}$ inches in ter and 26 inches stroke, climbing grades of 1 in 33, and were dopted in 1869.

;s. 22 to 27 will illustrate 4 systems of freight engine side The first rod is one of the six-wheel couple type in ordinary

practice, cylinders 18 by 22 inches; the second belongs to an engine with cylinders 18 by 24 inches and larger wheel. The details of the knuckle joint show the great simplicity of the latter method, the phosphor bronze bush in the solid rod joint being secured to the central portion by means of the oil cup, which is screwed into it from above. The third is the method of spherical bearings above mentioned, not much in use; and the fourth a recent adaptation of solid bushed ends to a Consolidation engine. It may be mentioned here that there is a tendency, among some engineers, to lessen the strokes of the side rod, which, however, can of course only be done on inside cylinder engines—as one instance of this a 7 foot diameter four-wheel coupled passenger engine recently designed, with 19 by 26 inch cylinders, has a coupling rod throw of only 18 inches.

The breadth of bearing for side rods is an important item in their length of service, and it is unfortunate that about $3\frac{1}{2}$ inches seems the greatest breadth obtainable for outside cylinder engines. Mr. Stroudley's engines, Fig. 5, and the freight engine, Fig. 23, have both inside cylinders and very broad bearings, $4\frac{1}{4}$ inches and 6 inches respectively.

We have thought best only to illustrate typical examples of the many drawings that have kindly been sent to us, though all information is valuable in writing a report of this kind.

MATERIAL.

Iron is still generally used for side rods, although steel is rapidly coming into favor, but we have no data to show that the weight of rod has been correspondingly reduced. Where steel has been adopted a better section has generally also been used, which enables the rod to be lightened.

Of the various mixtures of bearing metal each have their advocates; but phosphor bronze has been so successful that most bushes for solid end rods, and many sectional brasses, are now made of it. White metal bushes are very cheap, owing to the small amount of machine work on them, but they sometimes work loose, which is probably due to the continued knocking which must, more or less, alter their shape. A good mixture for such bushes is: Tin, 16; antimony, 2; copper, 1.

The Southern Railway of Austria, see Fig 7, make their bearings of wrought iron, lined with white metal; but this seems one of those details of continental work where expense is not an item of consideration.

Steel bushes have been successfully used for wrist pin joints where there is not much motion.

COST.

It is difficult to make a fair comparison between the cost of different styles of rod; but the following figures will help in forming an opinion:

	Material and smith work.	Machine labor.	Total.
Cost of making one set strap rods	$72	$50	$122
Cost of making one set strap rods, Fig. 1.	48	33	81
Average strap rods	60	41.5	101.5
Cost of making one set solid end (steel), as per Fig 14.	81.5	63.5	145
Cost of making bushed and grooved, Fig. 19..	72	50	122
Cost of making bushed and grooved, Fig. 4...	....	25.5	....

From these figures, which have been accurately calculated from different sources, we may infer that the cheapest rod is still the old strap rod, partly owing, no doubt, to the fact that what has always been made is easiest made; that the next cheapest is the solid bushed end, although with fluted sides, which is, as we have seen, the best rod where standard lengths can be maintained, and which bids fair, with a little practice, to be as cheap a rod to manufacture as the common strap ended one; and, lastly, that the solid end, with brasses and cotter, is the most expensive.

FINISH.

A great deal might be said on the time spent on finishing off rods. An engine is supposed by many people to be handsome when its

parts are polished and its colors brilliant; and to accomplish this much valuable time has been spent, and acres of emery cloth used. It is now more easily done by means of emery wheels, and some rods are allowed to go out straight from the grindstone and be painted. One of the largest railroads in England does not permit the rods to be touched after they come from the planer, but consider that a rod looks best when it shows least sign of laborious work. For a similar reason much of the beveling of edges has been discontinued, especially in busy times, when it is necessary to get out work quickly.

In conclusion, we may ask, are alterations and improvements to be made by the suggestions of reason, or are we to go on in the old way of keeping to old methods, and only modifying a piece when numerous failures have proved the necessity?

The latter method will, no doubt, in time eliminate the evils of weakness, but it would never show up the superfluously strong places which make an engine clumsy. On the other hand there are strains on a side rod which it is almost impossible to calculate, and which conditions of weather control.

Thus there are many points in locomotive engines, even in the small subject of side rods, which will have to be modified, until, some day, we may have a locomotive whose parts are so admirably proportioned that no one shall be stronger or weaker than another; when every part will be able, like every perfect organism, to perform its own duty with perfect ease and safety.

Extract from Mr. Stroudeley's Letter.

I enclose you tracings of my standard connecting and coupling rods. Each rod is forged out of a solid piece. We have 235 engines fitted with them; 50 are of the small size, the remainder being uniform with the drawings, but all alike in design. All of the connecting rods have been fitted up by one man who receives them from the machines and puts in the brasses, cotters, bolts, etc., and finishes the rod entirely. The same fitter also puts up the rods under the engine and keeps the whole of them in order, no other man being employed for rod repairs. The bolt which holds the small end strap together, prevents the wear by making the strap and rod quite solid, and the cotter has sufficient strength to prevent its deflecting; there

is, therefore, no wear on these parts which usually go to pieces quickly when fastened with the old-fashioned gibs. The large end is bored out, and the brasses are all turned to gauge, so that at out stations the driver can remove a set of brasses and put in spare ones without the use of a file; the worn brasses are sent to head-quarters and are filled up with white metal and rebored, to be used for any other engine.

In the case of side rods I have a great number that have been running since 1871, '72, and '73 to the present time without renewal to the bushes or pins. In no case has such renewal been required except where the driver has neglected the oiling. One of the large Good's engine, built in these works in 1871, was in the shops when the Iron and Steel Institute visited Brighton in 1881. The side rods were as close a fit after running ten years as when new, less than $\frac{1}{16}$ of an inch play on the pins, and they were of course sent out without any further work on them. Many of the engineers visiting the works were much struck by this durability, which is no doubt largely due to the use of case-hardened pins. We have these rods on express, tank, and Good's engines, the lengths being the same in each case. The side rods are thicker in the centre than at the ends. We plane them in an ordinary planing machine, bending down the rod at one-half the required increase of thickness, and after one side is planed the rod is turned over, bent down the reverse way, and when it is finished it is symmetrical and properly curved. I may here mention that not one of these rods has broken. I place the outside crank on the same side of the axle as the inside crank. The outside throw is 10 inches and the inside 12 and 13 inches according to the size of engine. The rod ends are case-hardened and the bushes forced in and held by a pin as shown on drawing. These bushes do not get loose.

In designing locomotive details I consider what is required to be done, and our present means of manufacture, instead of following old-fashioned designs, which were good enough in their day when tools and materials were very different from what they are at present.

I shall feel extremely obliged if you will give me a copy of your Report and some similar details of the cost of manufacture and durability of American designs.

London, Brighton & South Coast Railway. Details of Construction of a Connecting Rod.

	In the Rough.	Finished.
Total weight of wrought iron	627 lbs.	347¾ lbs.
Total weight of brass work	79½ "	53¾ "
Total weight of steel	¾ "	½ "
Total weight of rod	707¼ lbs.	402 lbs.

Time.

Smith's time forging	15¼ hours.
Turning	56¾ "
Drilling	27¼ "
Slotting	19¾ "
Planing	36 "
Fitting	70 "
Moulding	1 "
Total	226 hours.

Summary of Cost of one Connectimg Rod including Material and Labor.

Smiths'	£3	13s.	6d.	=	$17	64
Machines	5	5	5	=	25	30
Moulders'		4	8	=	1	12
Fitters'	3	10	0	=	16	80
Marking off		3	3	=		78
	£12	16s.	10d.	=	$61	64

Mr. Woodcock moved the report be received.

Carried.

Mr. BLACKALL, Delaware & Hudson Canal Co.—I have the honor to present to you Mr. Leander Garey, President of the Master Car Builders' Association.

Mr. Garey came forward and was cordially greeted by the President.

THE PRESIDENT—Gentlemen of the Master Mechanics' Association I have the honor of presenting to you Leander Garey, the President of the Master Car Builders' Association. We will take a recess of five minutes to enable the members to extend a kindly greeting to Mr. Garey, and examine the drawings of the different rods mentioned in the report—this is a subject that possesses a good deal of interest in this age of fast trains.

A recess of five minutes was then taken.

THE PRESIDENT—The discussion of the report just read by Mr. Fry, on Parallel Rods, is now in order.

Mr. FLYNN, Western & Atlantic Railroad—Those who are old in the cause know that we run our driving wheels with a great deal more spread than we did some years ago. I have found that the breaking of parallel rods, on my road, has generally been where the rods are somewhat old in service, say four or five years; that then they have become dangerous to run on fast trains. In the upper portion of our State we are running our express passenger trains almost as fast as you run them here. We have had some bad accidents to machinery; so far we have escaped without injury to the employees. I still cling to the old strap rod; and with all due respect to Mr. Fry's friend, who wrote the letter stating that in ten years' service there was only about one-sixteenth lost motion, there certainly must be less service or less hard work on the English engine than there is on ours, for we all know that none of our engines, even after a service of three years, would show as little wear as that. In fact, the pins themselves, in a service of three or four years, would be worn that much, perhaps more. My impression is that the breaking of the rods is due to their being in use too long. I have never known any in our section to break until they are four or five years old; it may be due, in some measure, to the climate. I have some which have been in use five years which are as good as the first day they were put on. I found, on one occasion, that a Baldwin engine after about eight years had the original rods on; I put new strap and rods on and they have now been running about three years. I used, for many years, to run the axles under our passenger service five years; one of them broke, fortunately without doing any damage, and I found that with our increased speed it would not do to run an axle five years. I now run them two and a half and use them five years under the freight; that is some seven or eight years ago, and since then we have never had a broken axle under our passenger service. My impression is if the parallel rods were closely watched and not allowed to run longer than a specified time, you would not have so many break. I do not believe in a heavy rod; I believe the lighter the rod the better, if it is properly proportioned. I think that where rods are broken after six months' service there must have been some serious defect in the material they were made of. I do not myself believe in steel either for crank pins or rods or driving axles; I believe in a good quality of wrought iron. I have had steel rods break in seven years, and I never had a wrought iron break under a service of thirteen years. I believe, as I said before, that a wrought iron parallel rod, properly watched, properly examined and not allowed to run too long, is just about as good a rod as you can get. If you have them properly proportioned, and watch them carefully, I think the accidents from the breaking of parallel rods will be lessened materially.

THE PRESIDENT—I wish to say a word on this question of side rods. I believe that the breaking of a great many rods is due to the fact that the rods are tampered with; in other words, they are tinkered by the engineers. Some of the engineers, notably the older ones, thought they were lucky if they ran over the road without loosening half a dozen nuts; that was the condition of things when they learned their trade, and they have not been progressive enough to keep up to the age. Now I know, in my own experience, that rods have been broken simply because the engineer would persist in keying them tight and tinkering them all the time. Now there is one strong argument, in my mind, in favor of the plain bushed rod—make your rods right, get the lengths exact, bore your bush out so that it will slip on freely, no matter if there is a thirty-second of an inch play, slip it on and that is the end of it. No man can tinker it. I believe that the failure of our rods, in a good many instances, is due to the fact that some incompetent engineer has been keying them. Now a strap rod that keys is something that can be tampered with; and an engineer thinks that in order to keep up with the times and make himself useful, and take good care of his engine, he must about once a month have his rods filed and lined and keyed, and the only wonder to me is that they run at all. I have been using, for several years, a solid end rod, with no bolts but a key. It is so difficult to take the box down and fill them and get them back, that the engineers let them alone; it is too much labor for them. I do not think that it is much labor to take them off; but they present a good deal of surface to be filed, and they are put up so that they will keep box to box solid and be perfectly free. I have run those rods over two years with out having a set screw started on them. There is a strong argument, I think, in favor of the bushed rod or a solid end rod, with the box held in with just a simple key. If they have straps the engineers can take them down and line them up, and they will continue to do so until you cut some of their heads off, then you may be able to stop it.

Mr. BRIGGS, Mobile & Ohio Railroad—There seems to be something very mysterious connected with parallel rods, and, inasmuch as our experience in regard to them is so diverse, I think there is something wrong somewhere. There are five engines on the road I represent, 16 by 22 cylinders, and 5 feet 8 inch wheels. When they were built I put old rods on them with new straps. Those rods are twenty-five years old now. They were built by the Danforth & Cook Locomotive Works. Our passenger trains make thirty miles an hour. They pull eight cars. Those engines will average 2,800 miles a month; and I have not had the first rod to break with me in all my railroad experience. I was taught originally that it was a bad idea to let engineers tamper with their rods. I will admit that there are many men running engines who are fully competent to take up the lost motion in their rods, but I have made it a positive rule that they must not do it. When I overhaul an engine, the first thing I am careful about is to see that the crank pins are perfectly true; and if they are the least bit eccentric, and

I think it is going to take much time to true them up, I take them out and put in new ones. I never overhaul an engine without being certain as to whether the pins are perfectly true. I have had those rods run eighteen months without the brasses being filed on them. We have made fast runs, and tested them in every way in which a rod can be tested, and the first rod has to break yet. My opinion is, that where we find rods breaking so often there is something wrong, and the care that is taken of them has a great deal to do with it. To illustrate: A gentleman who had charge of the New Orleans & Mobile Railroad had a fine lot of engines there. They were much newer than the engines on our road. He made remarkably fast runs over his road, and he was always troubled with the breaking of his connecting rods. Inasmuch as this subject had been discussed here before, I wrote to this gentleman to find out what I could, and I did not find out anything except that he was using a steel crank pin. Well, that did not suit me, because I prefer a steel crank pin to any other. Perhaps I might have been wrong in going behind the curtain; but I knew an intelligent man who was an engineer on that road, and had met with a great many accidents of this kind. I questioned him with reference to the breaking of these rods. He told me that it was because the pins were not true and the rods would shake. He would report the fact, and the machinest would go there and take up the lost motion while the rod was cold, and, of course, as soon as that engine got hot the rod was bad. Then it was not a hard matter to account for this trouble; and I believe, if we were to pay more attention to these little things, we would be more apt to find out the difficulties that assail us every day in our practice. We are apt to look too high for an explanation of the trouble. Now, I attribute my good fortune, in the first place, to the fact that my rods are not overtaxed. I do not believe a rod will live as long on a small wheel as it will on a large wheel with the same speed; therefore, I think, that if we take all these things into consideration, and take into account the work that the rod has to do, and treat it accordingly, we will get better results.

Mr. Clark, Northern Railroad of Canada—The only trouble I have had with connecting rods has been with the old-fashioned ones; and I have also had some trouble with the strap ends. I have now adopted the solid end with a single cotter. I find them to give satisfaction. I do not allow any of the drivers to meddle with those at all. Since we have done away with the old-fashioned rod, and have adopted a well-proportioned rod, we have had no trouble with breakages. The round rods gave us trouble. I have done away with all straps. I have the brass and just one following cotter, and they give satisfaction. I believe in wrought iron pins; I don't believe in steel. I have not the same reliance on steel as I have on iron.

Mr. Wilder, New York, Lake Erie & Western Railroad—It is undoubtedly a fact that we have been increasing the power of our engines and all that sort of thing, while we have not been careful enough in looking after

portions of the details; and I think, in this matter of side rods, pins, etc., we have not calculated on the strains upon the different points. I think much of the trouble is due less to the way we do our work, and to the condition of our track, etc., and the success our English friends have had in running rods so long, is due, to a great extent, I think, to the difference of the track, which is made the prime thing in England. If engines do not run well in England it is the fault of the mechanics who construct them; not any thing else

Mr. HOLLISTER, Valley Railroad—In the case of one engine, just out of the shop, I found the side rods were running hot. I measured the driving wheels, and found one wheel nearly an eighth of an inch larger than the other three. I had the wheels taken and turned off, and we had no more trouble with hot pins. I believe, where you put on new tires without turning them off, you may get into that trouble—without measuring. I believe in turning the tires. While the diameter may be right the circumference may not be right. I can very readily conceive how an eighth of an inch in the circumference of a wheel would make quite a difference in the wear of the rods. I believe, as our President says, that a great deal of the trouble comes from engineers tampering with the side rods. I try to prevent that as much as I can.

Mr. LYNE, American Machinist—With reference to the remarks of Mr. Briggs, I believe the breaking of connecting rods is not so much due to the construction of the rods as to the small details. For instance, I have known parallel rods to break on a locomotive owing, I believe, to the fact that when the driving wheels were placed in the lathe for turning off, the centres were drawn in order to take as little off the journal as possible; and it will be readily seen that drawing the centre throws the pins off the quarter. I know that this has been done in several shops. I have taken pains to measure the wheels after they were taken out of the lathe; and I found one of the pins an eighth of an inch off the quarter. In placing driving wheels in a quartering machine, unless the quartering machine is precisely true, and unless the wheels are placed under the engine exactly as they come out of the quartering machine, it will be found that the variation will be doubled. For instance, the quartering machine is, say, a quarter of an inch, and the right hand wheel of the quartering machine is placed on the left hand side of the engine, it will be seen that the wheels will be a sixteenth of an inch off the quarter. I think these small details are something that require a great deal of attention, and I believe that rods break through the careless manner in which these small details are attended to.

Mr. ROBINSON—I do not think I can throw much light on this subject, because I have been out of practice some years; but this steel rod question is of interest to me because it reminds me of old troubles. In 1862 we broke a steel rod about every three days. In the course of a couple of years from that we had our line relaid with steel rails, and instead of breaking

from six to ten steel rods a month we did not break that number in two years. So I think Mr. Wilder struck the key note when he said the track had most to do with it. That, as has been suggested, is one of the chief reasons why in England they have so little trouble with side rods. There the rails are laid with double heads, whereas we use the common T rail, and there is more spring to rails of this description. In the case of an engine running backwards over this kind of road the back wheels have no chance at all, and in almost every case if the engineer should attempt to run backwards on one of these bad roads he would know exactly where his side rods would break. I think that if proper mechanical proportions are observed in the engine, and the crank pins and all the parts are true and you have a good track, it does not matter much about your side rods, except that as engineers you should try to get them as light as possible. We found the lighter we got our side rods the better they were. I would like to say that it makes me happy to join my old brethren after an absence of five years. I have been much interested in the discussions; I was very much interested in this comparison of link gear and the Joy valve motion, and I can see ample scope for good work by the Association for many years to come.

THE PRESIDENT—I am sure that I reflect the sentiments of the Association when I say we are very glad to welcome Mr. Robinson to our meeting.

Mr. FLYNN, Western & Atlantic Railroad—In regard to the subject matter before us, I believe with Mr. Wilder that we do not pay proper attention to the proportions of our parallel rods as we go along. Between the engine of to-day, as we all know, and the engine of thirty years ago, there is great difference in both weight and size. I believe a parallel rod rightly proportioned and as light as possible for the size of the engine will give good results. I am not wedded to the old strap rod or to the solid end rod; but, like Mr. Briggs, I do not want my engineers to have anything at all to do with the parallel rods. I stopped that many years ago on our road; but still they will sometimes break. Now I have gone into shops and watched the men adjusting parallel rods, and they will take the parallel rod, no matter what position it was in, and adjust it right there. The parallel rod ought to be adjusted, as we all know, on the centre; but what I have stated is the habit in many shops that I have been in; and I suppose it arises, not from the intention of the man in charge to let it be done so, but from the neglect of those under him to see that the thing is done properly. I believe a parallel rod properly adjusted, with true pins, and properly quartered, can be made to run at the speed at which we are now running our fast trains with perfect safety, provided the material in the rods is perfect. Breakage of parallel rods mostly comes from imperfect material, imperfect adjustment and imperfect pins. I often have engines taken into the shop for repairs in which the pins look perfectly good, but when you come to measure those pins you will find they will not do. They may be perfectly round, but worn out of centre

in some cases almost a sixteenth of an inch. If you put those wheels back in the engine with the same pins in, you can not adjust your parallel rods but that they will break. To the neglect to examine those things closely I attribute a great many accidents.

Mr. BRIGGS, Mobile & Ohio Railroad—In order to justify my idea about going into the small details in this matter, I wish to relate a little circumstance that happened in my experience with reference to a quartering machine. About sixteen years ago I was foreman at the place I have charge of now, and we got from New York a steam engine wheel lathe with a quartering machine attached. As soon as we got it the first piece of work we had for it to do was the requartering of a pair of old wheels to put in new pins. I set a man to work to lay them off, and the master mechanic seeing what I was about wanted to know what I was doing that for. He said, " You have a fine quartering machine there which is all right." I said, "I think it is better to see if it is all right." I found that quartering machine had a sixteenth short, which would have made an eighth of an inch on one side of the engine. Now there are not so many mistakes made in that way; but I still contend that the great trouble is with the details somewhere; and if men who are troubled with these matters will go right to the bottom they will find the trouble is much smaller than they anticipated.

Mr. LYNE, American Machinist—Mr. Briggs' remarks have suggested to me an incident which happened in my own experience where the quartering machine was apparently all right. It was a quartering machine attached to a wheel lathe. The wheels were laid off properly and the holes bored for the pins, and when the pins were put in we found they were out three thirty-seconds. When I came to investigate the matter I found that using the wheel lathe for turning wheels had worn down the spindle about one-eighth of an inch, so that the wheels lopped down, and when the pins were put in they were not parallel with the axle. That shows how these little details will sometimes throw us out.

On motion, the discussion was then closed.

The report of the Committee on New Plans of Construction and Improvement of Locomotive Engines was read by the Secretary.

Report of Committee on New Plans of Construction and Improvement of Locomotive Engines.

To the American Railway Master Mechanics' Association:

GENTLEMEN—Your Committee appointed to report on the subject assigned them, viz.: New Plans of Construction and Improvement of the Locomotive Engine, beg leave to present the following:

The past year does not seem to have been a year of marked progress or special improvement of the locomotive engine; probably our

r mechanics, locomotive builders, and inventors, are satisfied the present attainments made in the line of progress in the loco-e; however, your Committee find that there are a number of vements under way which require time to develop, a few of we may notice.

Fontaine locomotive which was referred to in our last Annual ation, and to which we were looking for further developments the past year, seems to have failed to produce the results were looked for, and the "Keely Motor" has not made that lerful" trip from Philadelphia to New York which we have nxiously waiting to see; yet we find that there is substantial ss being made by our master mechanics and builders in getting d and *substantial* engines adapted for every-day work on fast ger trains, and also designed to haul the heavy cars which our d managers have introduced on all leading railroads of late, would *tax* the power of an engine built a few years ago. The ing letter was sent to master mechanics and locomotive rs asking for information on this subject:

Vill you kindly furnish me with any information, plans, photo- or tracings of any locomotive (different from regular standard es) you have built during the past year, accompanied with ds of their performances, and where located at present; also ng of any new appliances or changes you have made that have ved to be of value and have increased the efficiency of the loco-tive. This information is solicited in order that the Association have records of the progress made from time to time in the im-ement of locomotives."

Seventeen replies were received to the above, as follows:

Mr. A. B. Underhill, Superintendent Motive Power of the Bos- & Albany Railroad has made a new departure in locomotive ctice, in building locomotive boilers to carry a working pressure 160 pounds per square inch, but intends to carry 175 pounds if finds it necessary. Mr. Underhill furnished your Committee a of blue prints, giving a full and complete description in detail of construction of these boilers. One of this class of engines is in rice, and thus far has given very satisfactory results.

Mr. Howard Fry, Superintendent of Motive Power of the New k, West Shore & Buffalo Railroad Company, furnished your

Committee with a tracing of the location of arch pipes and deflector as designed and used by him, while engaged on the Pennsylvania & Erie Railroad, for the prevention of smoke in locomotives burning bituminous coal. He says that it is well known that the English practice is to introduce iron deflecting plates over the fire doors. These plates burn out very rapidly even in England where the consumption of coal per foot of grate service is less than on American locomotives, and in American practice these plates have been found to last so short a time that their use has been discontinued.

The Pennsylvania Railroad's method of supporting the brick arch on water tubes suggested a very convenient plan for carrying the brick deflection over the fire door, running the two centre water tubes into the back sheet instead of into the crown sheet, leaving the two side tubes in their usual places, and then continuing a narrow row of bricks on the two centre tubes from the brick arch back to the back sheet. This forms a good deflector, and with it a careful firemen can keep up steam without making much smoke.

The Baldwin Locomotive Works, of Philadelphia, Pa., have furnished your Committee with photograph of a class of locomotives designed and built by them, at their works, called the *Decapod Class* having ten driving wheels and a pony truck: Cylinders, 18 inches diameter and 20 inches stroke; driving wheels, 37 inches diameter; total wheel base, 18 feet 8 inches; driving wheel base, 13 feet; boiler, 54 inches diameter; flues, 16½ feet long; fire box 50½ inches long, 48½ inches wide, and 55½ inches deep; the fire box overhangs back of the driving wheels, and is adapted for burning wood, as shown by photograph, etc., No. 20. Photograph No. 10 shows a narrow gauge consolidated engine, with fire box overhanging back of the driving wheels, also arranged to burn wood. The following are her principal dimensions: Cylinders, 16 inches diameter, 20 inches stroke; driving wheels, 37 inches diameter; total wheel base, 15 feet 5 inches; driving-wheel base, 9 feet 9 inches; diameter of boiler, 52 inches; flues, 13 feet 3¾ inches long; fire box, 43½ inches long, 48½ inches wide, and 54½ inches deep.

The Baldwin Locomotive Works have designed a *Steam Reverse Gear* for locomotives. One of the same has been in service for the past year on engine 69, a locomotive built for fast passenger service for the Central Railroad of New Jersey. This reverse gear has

worked very satisfactory, and is still in service. A photograph and description of same is here shown with detail, etc.:

NEW STEAM REVERSE FOR LOCOMOTIVES.

In the American Machinist of January 7, 1882, we published a detailed description of the swiftest American locomotive, No. 169, now running upon the Central Railroad of New Jersey. We publish here, with an engraving, a description of the steam reverse used upon that locomotive. It consists of two cylinders, one for steam and the other for oil. The piston in each cylinder, as will be seen from the engraving, is attached to a single piston rod E, which is connected with the lifting shaft J, by means of the jaw M and pitman L. The links are suspended from the arms I. The reader will observe that on engine No. 169, in order to raise the cylinders to the proper level upon the side of the boiler, a lever has been interposed between the upper end of lifting shaft and pitman L, which reverses the motion. This will be easily understood by an inspection of the engraving of the locomotive in the American Machinist.

In the engraving Fig. 1 represents a plan, and Fig. 2 an elevation of this steam reverse. The dotted lines plainly show the internal arrangement.

The oil cylinder has a port running from end to end, with a plug stop cock in the middle. The oil cylinder is kept full of oil at all times, being filled through a cup placed upon the port, so that it is impossible for the piston to move except when the plug cock is opened. This arrangement is shown in Fig. 4. In filling the cylinder a small vent plug, in the highest part of the port, is removed to allow the air to escape and the cylinder allowed to fill full of oil. The steam slide valve and plug cock are operated simultaneously by being connected with the lever G, which works upon the pin F.

A quadrant, P Q, is placed in the cab, and is bolted to the boiler by the foot O C. The small reverse lever is operated the same as the usual reverse lever, and in the same directions, being connected with the lever G by the rod N U.

An indicator R is also located upon the same pin as the reverse lever, inside the quadrant, for indicating the position of the links and point of cut off at all times.

This is done by means of a conection through the rod K with the lifting shaft, and the graduations upon the quadrant show the point of cut off.

To reverse the engine, throw the reverse lever in the direction desired until it strikes one of the stops S, which will place the steam valve and plug cock in the position shown in Figs. 5 and 3, and when the piston has moved its full stroke, place the lever in the notch at mid gear.

In adjusting the cut off the reverse lever is moved in the same manner, and when the point of the indicator shows the desired cut off place the lever at mid gear.

The slide valve upon the stem cylinder is placed low so as to drain all water of condensation from the cylinder. Some of the advantages of this reverse are that any desired point of cut off may be used, which change would require the shifting of the lever from one notch to another in the ordinary reverse lever. This is often very troublesome where there are an insufficient number of notches in the quadrant, and necessitates a partial closing of the throttle.

The plug cock locks the oil so as to hold the links in any desired position for any length of time. By the arrangement of the reverse upon engine No. 169, the reverse gear is handled with the two motions so that engineers are not likely to become confused when in danger of collision or of obstructions. Locomotives having unbalanced slide valves are handled with the greatest ease by means of this steam reverse. It is the invention of William P. Henszey, of the Baldwin Locomotive Works, Philadelphia, Pa.

The Chairman of your Committee presents a photograph of a class of locomotives designed especially for fast passenger service, built at Baldwin's Locomotive Works of Philadelphia. A reference to these engines was made at our last Annual Convention. He would also state that this class of locomotives have performed their work very satisfactory, and have fully met our expectations. Six more of the same class of engines have just been placed on the road. The advantages and principle dimensions are as follows:

[The Association is indebted to the American Machinist for the following description and remarks in regard to this remarkable class of engines, and, also, for many of the engravings which appear in this report.—SECRETARY.]

THE SWIFTEST AMERICAN LOCOMOTIVE.

With the rapidly increasing passenger traffic upon the railroads in this country has also come the necessity of increased speed, and today all the railroad companies controlling trunk lines are striving with each other to see which can make the best time with express trains. The Master Mechanics' Association have a standing committee appointed to determine which is the best form of fast passenger locomotive. The locomotive builders are also exercising their brain actively in endeavoring to produce a locomotive that shall combine power, speed and economy—three essential requisites in accomplishing the service desired. The engraving represents locomotive No. 169, lately built by the Baldwin Locomotive Works, of Philadelphia, for the Central Railroad of New Jersey, designed particularly for fast passenger service. This locomotive is considered by its builders to be their best design, combining more desirable features than any other style of locomotive ever built at their works.

Four locomotives of the design here shown (viz.: two with 18 by 24 inch cylinders, and two with 19 by 24 inch cylinders) are now running upon the Central Railroad of New Jersey, with the object of determining which of the two sizes is the better.

In general appearance the locomotive shown in the engraving resembles the usual style of first-class eight-wheel locomotives, but with some very important improvements. In order to supply steam to larger cylinders a larger furnace, more heating surface, and greater boiler capacity are required.

In the ordinary passenger locomotive the boiler sets inside the frames, and the necessary water spaces at either side of the fire box greatly reduces the width of the fire box. These water spaces are made as small as is considered safe, in order to get the necessary grate surface. To overcome one evil another is introduced.

Since the introduction of anthracite coal as a fuel upon locomotives a larger heating surface is required. At first only the best quality was used, but lately coal dust has been successfully burned to some extent. The true advantages of this, however, are still an open question. Boilers have recently been placed upon the top of the frames which admits of their being made as wide, or wider, if

necessary, than the outside of the frames. This improvement admits of a wider fire box and larger water spaces, but the boiler sets higher, and the depth of the fire box is very much reduced. To overcome these objections the design shown in Fig. 1 has been adopted in the class of locomotives here represented. It will be understood by those familiar with the working of locomotives that the hottest part of the fire box is at the front end, and the greater portion of the fuel (anthracite coal) is burned upon the front half of the grate. Fresh coal is placed just within the door, and the jarring of the coal upon the inclined grates V, when the locomotive is running, feeds the coal ahead as fast as it is required to supply the fire. It is, therefore, highly necessary that the fire box be made deeper at the front part. To accomplish this, the frames, instead of being made straight upon the top, are inclined from N to the middle of the main pedestal jaws M, as shown in Fig. 1.

This design makes a very strong job, and allows the grate bars to be placed quite near the bottom of the boiler. Where the boiler is straight upon the bottom, as upon straight frames, in order to get a sufficient incline of the grate bars, a large space is left at the back end of the fire box, between the under side of the grate bars and the bottom of the boiler. It will be observed that this space in the engraving is quite small. The boiler is strongly bolted to the cylinder saddle, which is formed of two pieces, each cylinder being cast solid with the saddle, and bolted together at the centre. The back part of the boiler is strongly supported by four links H, which allow a free expansion without springing the frame. Particular attention is directed to the ingenious method of arranging the springs and equalizing bars.

The equalizing bars I, also the back springs K, are located between the frames in spaces which are in most engines unoccupied, while the equalizers J, placed upon top of the driving boxes, occupy the place of saddles. The main springs L are located in the usual position, over the main driving boxes, while all the springs are easy of access.

The ash pan is arranged as shown at S. T, having slides at the bottom for the removal of ashes and clinkers.

The tail end of the frame is made in a very substantial manner

for the drawhead, as shown at U, the wear iron upon the tank being represented by W.

This arrangement is better shown in Fig 3, which represents a cross half-section through line A B, and end view of locomotive. The tail piece is shown at P, and the lower brace for drawhead at O being strongly bolted together. There are three solid grate bars N, which may be partly or wholly withdrawn in knocking out or cleaning the fire. This may also be seen in Fig. 2, which shows half-section through line C D of Fig. I. All except the three solid grates are hollow-water tubes, as shown at M, Fig. 2. A cross section of back spring is shown at C. The circulation of water about the fire box is excellent, on account of the enlargement at the top, shown at A, in Fig. 3. Generally, the space at A is the same as at B, which does not give as good a circulation, because the globules of steam, in rising toward the surface of the water, require more space as they expand.

The crown sheet is strongly supported by bars shown at J, the ends supported by the castings K, which rest upon the edges of the crown and side sheets.

The running boards E are wholly of sheet iron, with edges formed of T iron, as shown at G. Within cab F the running boards are covered with wood.

This locomotive is furnished with a steam reverse, operated by only one lever by a single motion, which will be illustrated and described in detail in a future issue of the American Machinist.

The connections with the lifting shaft are shown at P O, in Fig. 1. In case any of the pins should work out of the link motion the front ends of the eccentric rods are prevented from falling on the track by a guard Q, of round iron, extending across below the frames. The side rods are made large at the centre, as shown in Fig. 4, and will be easily understood from the detailed dimensions.

Through the kindness of William Woodcock, master mechanic of the Central Railroad of New Jersey, we made a trip on this locomotive (No. 169), and were very much pleased with the ease with which the engine performed its work.

The train usually consists of five cars, viz.: one baggage, one express, one Pullman drawing-room coach, and two ordinary passenger coaches. With this train, and notwithstanding the fact that the

smoke stack is well enclosed within the smoke box, to prevent throwing fire, plenty of steam is generated at all parts of the road. The distance from Jersey City to Bound Brook is 32 miles, and the regular schedule time between stations is 37 minutes. This distance has been run by No. 169 in 33 minutes. Three miles upon the route have been run in 2 minutes and $24\frac{1}{2}$ seconds—the same distance frequently covered in $2\frac{1}{2}$ minutes. The quickest mile ever run by this locomotive was in 45 seconds, timed between mile posts with a stop-watch.

This is the best railroad time we ever heard of. W. C. Aten, the engineer, says: "She is the boss, and behaves as if she liked an opportunity to make up a little lost time." We are informed that with this style of locomotive very little time is ever lost upon the road.

We append the following dimensions of details:

Gauge of road	4 feet $8\frac{1}{2}$	inches.
Boiler material, Otis steel; thickness	$\frac{3}{8}$	"
Diameter of shell	52	"
Style, wagon top.		
Fire door, diameter	16	"
Dome over fire box, diameter	32	"
Fire box sides, corrugated, length	$125\frac{7}{8}$	"
Width, sides, corrugated, length	$43\frac{3}{4}$	"
Depth, front, corrugated, length	$51\frac{3}{4}$	"
Depth, back, corrugated, length	$42\frac{1}{2}$	"
Material, Otis steel; crown sheet, thickness	$\frac{3}{8}$	"
Tube sheet, thickness	$\frac{1}{2}$	"
Side sheets, thickness	$\frac{1}{4}$	"
Back sheets, thickness	$\frac{5}{16}$	"
Water space, back, thickness	4	"
Water space, front, thickness	3	"
Water space, sides, thickness	3	"
Crown bars, sides, thickness	5 by $\frac{3}{4}$	"
Crown bars placed above crown sheet	$\frac{1}{2}$	"
Crown bars, bolts $\frac{7}{8}$ inches, screwed through sheet, with nut below.		
Combustion chamber	5	"
Tubes, iron, No. 12, wire gauge.		
Tubes, ends swayed for copper rings at fire box ends.		
Tubes, number	200	
Tubes, diameter	2	inches.

Tubes, length	11 feet 5⅞ inches.
Dry pipe, wrought iron, diameter	8 "
Grate, water tubes	2¼ "
Grate, are in square feet	38 square feet.
Heating surface in fire box	145 " "
Heating surface in tubes	1,175 " "
Heating surface, in total	1,320 " "
Steam pressure per square inch	140 lbs.
Wheel base rigid, driving wheel	7 feet 6 inches.
Wheel base rigid, total	21 " 8 "
Weight of locomotive in working order	93,000 lbs.
Cylinders, diameter	18 "
Cylinders, stroke	24 "
Steam ports, length	16 "
Steam ports, width	1⅝ "
Exhaust ports, width	3 "
Bridges, ports, width	1⅜ "
Valve, Allen's.	
Valve, travel	5½ "
Valve, lap outside	⅞ "
Valve, lap inside	$\frac{1}{32}$ "
Lead	None.
Eccentrics, throw	5 inches.

Exhaust, nozzles, 3¼ inches; diameter, double.
Crosshead, wings, phosphor bronze.
Rod, brasses, phosphor bronze.
Piston rods, steel.
Packing rings, brass, with springs and studs.
Heads and followers, cast steel.
Connecting rods, Otis steel.
Side rods, taper, 4¾ inches at ends, and 5½ inches at centre.

Thickness	1⅜ inches.
Driving wheels, diameter	68 "

Solid spokes and rims.
Standard steel tires.
Driving axles, Otis steel.

Driving axles, journals, diameter	7½ inches.
Driving axles, journals, length	8½ "

Brake, Westinghouse automatic.

Smoke stack, straight, company's style, height above rail	14 feet 10 "
Opening	16¾ "

No pumps, two injectors instead.

Trucks, 4-wheeled, swing bolster.
Pedestals faced with steel plates.

Diameter of wheels	32	inches.
Journals, diameter	5½	"
Journals, length	8	"

Tires, standard steel.
Tender, 8-wheeled.
Tender frame, iron.

Capacity .... 3,000 gallons.

Made of Otis' steel, top, bottom, and sides No. 4, and outside No. 8, wire gauge.

Wheels, diameter	30	inches.

Plate, Washburn, steel tired.

Journals, diameter	5	"
Journals, length	8	"

All truck axles, both on engine and tender, made of Otis' steel.

In a letter lately received by the Chairman of your Commi from W. W. Evans, associate member, Mr. Evans presen sheet showing the comparative profile of mountain railro thinking it would be interesting to the members of the Associa to see how high locomotives are run in Peru above all the o railways in the world. The sheet here appended shows all the l summits of railways in Europe; they are all plotted to the s scales. This sheet was compiled by Mr. Helvage, engineer of St. Gothard Railway, in Switzerland, and reproduced by Mr. Ev on the railway in Peru, running from Aarequipa to Lake Tit a distance of 70 miles; this is more than 16,000 feet above the and nearly the whole distance is bare rock. Mr. J. E. Martin, of our members, is locomotive superintendent of the above rail

Mr. L. B. Paxson, engineer of machinery on the Philadelph Reading Railroad, furnished your Committee a very complete s blue prints and photo-lithographs, with descriptions of details, showing the standard engines as used on their road—as shown t engines differs somewhat in their constructions from the ordi engines in railway service; the principal feature and depa being in the design and construction of the boiler. This boiler designed by Mr. J. E. Wooten, at present general manager of above railway, and is the standard boiler for this road. The al class of engines are especially adapted for burning anthracite

they are in continuous service and their performance is very satisfactory.

The following are the principal dimensions:

Philadelphia & Reading Railroad Company, Engine for Passenger Service.
General Dimensions.

Cylinders	21 by 22 inches.
Diameter of driving wheels	67 "
Diameter of truck wheels	33 "
Wheel base	21 feet 1 "
Diameter of boiler at smoke box	53 "
Diameter of boiler at fire box	58¾ "
Number of tubes	184
Length of tubes	10 feet 2½ inches.
Diameter of tubes (outside)	2 "
Length of fire box (inside)	9 " 6 "
Width of fire box (inside)	8 "
Combustion chamber	31 inches long.
Grate area	76 square feet.
Heating surface of tubes	982 " "
Heating surface of fire box	123 " "
Heating surface of combustion chamber	32 " "
Total heating surface	1137 " "
Diameter of smoke stack	20½ inches.
Exhaust nozzle, variable form	3¾ to 5¾ in. diam.
Weight on driving wheels	64,250 lbs.
Total weight of engine	98,200 "

Mr. Paxson says they have lately introduced the steam reverse on the above engines, as designed by Mr. Good, and styled "Good's Steam Reverse for Locomotive Engines;" a set of blue prints is here appended, showing construction and detail of same; also, a full description of the arrangement as applied to a locomotive. This steam reverse differs from the one previously referred to in that it has only *one* cylinder instead of *two*. The above is now being applied to the engines on this road and is working very satisfactory.—See general description, page 119.

Mr. G. E. Boyden, superintendent motive power and machinery of the New York & New England Railroad, furnished your Committee with blue prints showing plan of fire-door opening by flanging the sheets as shown. He says that in twelve years continuous service

with the above he has found no trouble with the same. While this device is not new, yet it shows the result of practical use of the same.

[This is a design in general use, and, it is thought, sufficiently well known without reproducing here.—SECRETARY.]

The attention of the master mechanics in the United States has been lately directed to what is known as "Joy's Patent Reversing and Expansion Gear," as applied to locomotives. This invention, as shown, dispenses with the links and eccentrics as now in present use, and is operated from a connection on the main rod. So far as is known to your Committee this arrangement has been only applied to one locomotive in this country, viz., on engine 411 on the Philadelphia & Reading Railroad. Through the courtesy of Mr. L. B Paxson, engineer of machinery of the above road, the chairman of your Committee was invited to ride on this engine while on a trial trip made recently between Philadelphia and Bound Brook. This engine has been placed in regular passenger service in order to make comparative tests of this improvement.

[See paper on this subject, page 55.—SECRETARY.]

Your Committee have received a very new and novel design for the prevention of breaking of parallel rods, styled "Strong's Locomotive Driver Coupling," as shown in the accompanying engraving.

As one of the difficulties to be surmounted in running fast passenger trains is some device or plan that will prevent the rods from breaking, the above is worthy of attention. We also present blue prints of a heater and purifier adapted for the locomotive, as shown.

As the attention of the Convention has been called to notice the matter of carrying high pressure of steam on locomotive boilers your Committee present a new design of boiler, which has some very important features in it, particular as there is great strength, as shown in its construction, there being no flat surfaces; and another feature is in the manner of providing for combustion of the gases. This boiler has not as yet been in practical service, but it is no doubt worthy of notice.

In conclusion, your Committee will say they have endeavored to collect and present what is thought to be worthy of notice, so far as it was possible to do so; they would recommend that the reports and

accompanying blue prints be printed in the Annual Report; they also recommend that this subject be continued.

Yours, very respectfully,

WM. WOODCOCK, *M. M., C. R. R. of N. J.* } *Committee.*

Good's Steam Reverse for Locomotive Engines.

This steam reverse gear has been designed for locomotive engines for the purpose of giving relief to the engineer, and promptness to the reversing movement of the engine. Among its advantages are simplicity, freedom from derangement, cheapness of construction, minimum effort on the part of the engineer to reverse his engine, and also the almost automatic movement of the reverse lever, which, if simply started, will continue its movement in that direction until, by dropping the latch into the quadrant notch at the desired point of cut off, its further movement will be arrested, and the link gear of the engine will simultaneously be adjusted to the position corresponding with that of the reverse lever, and will remain fixed in that position until further change is made by the reverse lever.

By this it will be seen that not only is the link gear of the engine moved by the steam reverse, but also the reverse lever has communicated to it, by the peculiar arrangement of the reverse gear, the necessary force to move it in the desired direction without any effort on the part of the engineer save that of simply starting it. Another advantage possessed by the device is that the reverse lever is operated in the same manner as those in general use.

The accompanying sectional print No 2, showing the principle of the apparatus, will afford a ready insight into its working.

A represents the steam cylinder provided with two induction and one eduction ports, steam valve E, piston B, and piston rod C, the last connected to the reverse arm D of the link gear of the engine.

The reverse lever H is connected by the reach rod G to the lever F at F^3, which in turn is connected at F^2 with the reverse arm D at at D^2; and at its lower extremity, at F^1, is connected with the valve rod which in turn is connected with the of the arm steam valve E.

The operation of the reverse gear is as follows: The stop valve upon the boiler is opened and adjusted so that the flow of steam into

the chest occupied by the valve E shall be limited to that quantity which will give the most desirable promptness of movement to the link gear of the engine and ease of movement to the reverse lever. If the reverse lever H is moved slightly toward h, then will the point F^3 be moved forward; but since the point F^2 is at this moment stationary, then the movement of F^3 will be communicated through F^1 and the valve rod E^2 to the valve E, uncovering the port d and admitting steam into the steam cylinder A, and driving the piston B toward b. Simultaneous with this movement of the piston there will take place the movement of the reverse lever in the same direction; both of which will continue so long as steam under pressure is admitted by the valve E into the cylinder through port d; but when the reverse lever H is arrested in its movement toward h, then will the point F^3 (which had been moving toward f) become for that interval of time a fixed point, and the still continued movement of the arm D toward d^2 will move the lever F at F^2, and thus cause the steam valve to close over the port d and permit the accumulated steam to be discharged from the steam cylinder through the eduction port into the air.

The piston rod C is of such diameter, and its glands of such length, as will afford the necessary resistance to the movement of the piston whilst the locomotive is working under steam, and which resistance must be in excess of the reciprocating tendency of the piston and rod, due to the working of the link gear of the engine.

If, however, the friction upon the piston rod is not sufficient to hold the link gear firmly in place, then will any creeping movement of the arm D be communicated from D^2 to the lever F at F^2; but since the reverse lever is at this time in a fixed position, then also is F^3 a stationary point, and therefore the said movement, communicated to F^2 from D, will be inverted at F^1, thus gradually adjusting the valve E to make the admission of steam into the cylinder A through one of the ports, sufficient to arrest the further movement of the piston B and arm D; or briefly: The proper resistance upon the piston rod can be adjusted and maintained by tightening up the glands upon the piston rod from time to time; and if, through neglect or other cause, the resistance of the piston rod is not sufficient for the force of the link gear, then will the valve movement of the steam reverse automatically produce the necessary resistance to maintain the link gear of the engine in a fixed position.

This steam reverse gear, as shown in Plate 1, has been applied to a number of locomotives on the Philadelphia & Reading Railroad, and they have in every instance given the most satisfactory results. There are at this time a number of engines under construction at the works of this company, at Reading, to all of which this reverse is being applied.

On motion, the report was received and the recommendation of the Committee adopted, and ordered to be placed on file, and it was agreed that the discussion of the report should be deferred until the following day's session.

The report of the Committee on the Best Method of offering Premiums to Engineers and Firemen to induce Economy in the Running of Locomotive Engines, was read by the Secretary and accepted, and it was agreed to continue the Committee for the ensuing year.

Report of Committee on the Best Method of Offering Premiums to Engineers and Firemen to Induce Economy in the Running of Locomotive Engines.

To the American Railway Master Mechanics' Association:

GENTLEMEN—Your Committee to whom was referred the subject of Best Method of Paying Premiums to Locomotive Engineers and Firemen to induce Economy in the Running of their Engines, respectfully beg leave to submit the following report:

Your Committee found the subject was of such magnitude that, owing to the great difference in the systems of keeping accounts on our railways, a new plan would have to be devised to meet the change proposed. Such a plan your Committee have not had time to work out; but we think the subject of so much importance that we respectfully report progress, and ask that the Committee be continued.

F. M. WILDER,
HOWARD FRY, } *Committee.*

The report of the Committee on Standard Wire Gauge being called for, Mr. FRY, New York, West Shore & Buffalo Railroad, moved that the discussion be opened without reading, as the paper had been printed and distributed to the members.

THE PRESIDENT—If the Secretary will read the recommendations of the Committee that will be perhaps sufficient.

Mr. FRY, New York, West Shore & Buffalo Railroad—I accept the amendment.

The motion was carried, and the recommendations of the Committee were read.

Report of Committee on Standard Wire Gauge.

To the American Railway Master Mechanics' Association:

GENTLEMEN—As Chairman of Committee to whom the duty of investigation as to the merits, etc., of the different wire and sheet-metal gauges now in use, and also as to the advisability of adopting a standard gauge, I would respectfully state, that after giving the matter my personal attention, and having received the expression of opinion of many of the larger manufacturers "all over this country," I have come to the conclusion that an "American Standard Wire and Sheet-metal Gauge" is an actual necessity, and the sooner one is adopted the better both for the manufacturers and consumers. I find that manufacturers have on hand and in use different kinds of gauges, all of which are seemingly appreciated by them, not because of their particular merits but simply for the want of better.

All with whom I have communicated desire an improvement; I say, after making the subject a specially, I am fully convinced that for practical use, uniformity and accuracy we have no such standard.

The following correspondence, pertinent to the subject, which has, on application, been kindly sent me, will doubtless prove interesting and useful to the Association.

Extract from *communication* of Coleman Sellers, of Philadelphia, Pa., to me, reads as follows:

I think that plates should be rated by their thickness in inches, and the decimal of an inch conforming, as far as possible, to the existing division of the inch, by the binary division, thus, $\frac{1}{2}$ inch, $\frac{3}{8}$ inch, $\frac{1}{4}$ inch plates answer the purpose of the trade and the purpose of calculated strength better than the expression of the thickness of the spaces in a gauge, which spaces must be translated into inches.

Before they can be used in computations, when we get below $\frac{1}{16}$ inch, it may be well to have some gauge; but even in this case I am inclined to favor the use of the small plate gauge, with screw, made by Brown & Sharpe, and the expression of all thickness by the thousandth of an inch. I do not believe in this thing of a gauge

founded on the French measures, because I hope the craze for that system is on the decrease, and that in America we will never adopt the French system.

I have expressed my views on this matter in a paper read before our Association of Mechanical Engineers, some years ago, I refer you to it for what I think, and I now supplement that paper by one which I read before the American Society of Mechanical Engineers, last year, and of which paper I now send, by the same mail, a copy to you to refer to if you are inclined. I am sorry I can do so little to aid you in this subject, and trust that what I have given you will in some way help you in getting what you want. Please command me if I can answer any specific questions in the matter, and believe me, my dear sir,

Yours truly,

COLEMAN SELLERS, *of Philadelphia, Pa.*

CLEVELAND ROLLING MILL CO., CLEVELAND, OHIO.

R. H. BRIGGS, ESQ., *M. M., M. & O. R. R.*

DEAR SIR—Your favor of November 22d at hand. We have for the last ten years been in the habit of using what is known as the "American Standard Wire Gauge," by which we draw our wire and roll our sheet and plate. This gauge, we know, is used by a large proportion of American manufacturers; and although we do draw our wire to other gauges, which are specified as English Gauge, the Birmingham Gauge, Brown & Sharpe's Gauge and Stubbs' Gauge, still we are in the habit of asking from our customers samples of what they require, showing the exact gauge.

We would much prefer to have one gauge used by all consumers in this country, to be known as the "American Standard Wire Gauge;" but we know of no way, perhaps, by which this could be brought about except through your Association.

Yours truly,

ED. S. PAGE, *Secretary.*

Extract from Miller, Metcalf & Parkins' Treatise on Gauges, also quoted by permission:

In consequence of the absurdities and anomalies existing in our present system of guages, we recommend the use of the inch as a

unit of measurement. There are in use at the present time three standard gauges, as follows:

Nos.	Stubbs' Decimals of One Inch.	Stubbs' Decimals of One Inch.	Brown & Sharpe's Decimals of One Inch.
1		.300	.28930
2		.284	.25763
3		.259	.22942
4		.238	.20431
5		.220	.18194
6		.203	.16202
7		.180	.14428
8		.165	.12849
9		.148	.11443
10		.134	.10189
11		.120	.09074
12		.109	.08081
13		.095	.07196
14	.083	.083	.06408
15	.072	.072	.05706
16	.065	.065	.05082
17	.058	.058	.04525
18	.049	.049	.04030
19	.040	.042	.03589
20	.035	.035	.03196
21	.0315	.032	.02846
22	.0295	.028	.025347
23	.027	.025	.022571
24	.025	.022	.0201
25	.023	.020	.0179
26	.0205	.018	.01594
27	.01875	.016	.014195
28	.0165	.014	.012641
29	.0155	.013	.011257
30	.01375	.012	.010025
31	.01225	.010	.018928
32	.01135	.009	.00795
33	.01035	.008	.00708
34	.0095	.007	.0063
35	.009	.005	.00561
36	.0075	.004	.005
37	.0065		.00445
38	.00575		.003965
39	.005		.003531
40	.0045		.003144

In some cases the difference between two numbers falls as low as two thousandths of an inch, in others it is only one thousandth, etc. It may be possible to make one gauge to any of these standards

which shall be so accurate as to defy the detection of an error, and with the same care it may be possible to make a thousand such gauges; but every mechanic, and every person accustomed to making accurate measurements of the best work, knows that it is simply impossible to obtain absolute accuracy in such pieces of work when produced in large quantities, and it is impossible, commercially, on account of the cost.

Every one knows of the wonderful accuracy of Whitworth gauges, and also their enormous price, which makes them almost unsalable.

In regard to ordinary wire gauges they are notoriously inaccurate, because they can not be made accurate, and be at all salable.

In a recent case a sample under discussion measured on one gauge tight twenty-three, and on the other tight twenty-four, and our customer said it was neither by his gauge.

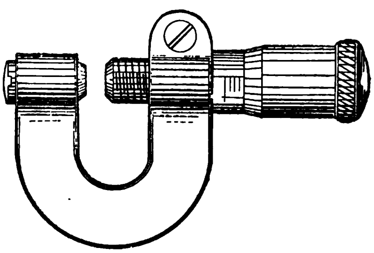
A new gauge in our possession has its No. 23 so much larger than its No. 22 that the difference can be easily detected by the naked eye, yet No. 23 ought to be two to four thousandths smaller than No. 22.

If we were to roll No. 23 by that gauge, how would our customer get what he wanted, unless his gauge accidentally contained the same blunder?

Another trouble is with the wearing of the gauges, for which there is no remedy, and we imagine that no man ever throws away a gauge because it is worn out; on the contrary, it represents an outlay of several dollars—he is used to it, he measures everything by it, and he is mad when anything does not measure to suit. A still more serious difficulty arises from a very common mode of ordering. We frequently have orders for such a gauge: "Light" or "tight," "full" or "scant," "heavy" or "easy," or such a number and one-half, for instance, 15½. The latter is terribly confusing to a roller; he almost always takes it to mean that it is to be thicker than the whole number, and is pretty certain to make it 14½ for 15½ if he is not warned beforehand.

Then in regard to the terms "light," "easy," etc., we have, for instance, the difference between Nos. 27 and 28 in the three systems, as follows: .00225, 001554, or, two hundred and twenty-five hundred thousandths, and fifteen hundred and fifty-four millionths.

How is it possible for a roller to know just how many millionths of an inch another man, whom he never saw, means when he says No. 28 "full," or No. 27 "easy?" and how is he to guess how many thousandths of an inch the other man's gauge is wrong in its make, or how many hundredths it has worn in years of steady use? This is no fancy sketch; the above are every-day difficulties in this age, when every man knows just what he wants, and will have nothing else, and yet has no better way of telling his wants than to say I want such a gauge "tight," when probably his gauge differs from every other gauge that was ever made.



There is a very easy and simple way out of this whole snarl, and that is to abandon fixed gauges and numbers altogether, and use the micrometer sheet-metal gauges, which measure thousandths of an inch very accurately, and even a quarter of a thousandth may be neatly measured.

They are very simple, so that any boy of ordinary intelligence can be taught to use one in a very few minutes. They have very easy arrangements for readjustment when worn, and even when worn considerably they can be used accurately without adjustment by making allowance for the error in reading at the zero line. We find that mechanics like to work to them, and that there is very little trouble to get sheet rolling done to within a thousandth of an inch on fine sizes.

I hope, Mr. President and gentlemen, that this matter will receive the consideration from this Association it deserves, and that you will honor yourselves by adopting a truly American Standard Gauge; and, in view of that end, I most respectfully recommend for adoption the Micrometer Gauge, made by Brown & Sharpe, Manufac-

turing Company of Providence, Rhode Island. It is recommendable: 1st, For accuracy in measurement; 2nd, Its ease of adjustment; and, 3d, For its durability. It measures by the thousandths of an inch very accurately; is very simple in construction; special sizes can be made suitable for tool work when so required.

I take this means of returning thanks for valuable information received on above subject to the following named gentlemen: Coleman Sellers, of Philadelphia, Pa.; Ed. S. Page, of Cleveland Rolling Mill Co.; Miller, Metcalf & Parkin, of Pittsburg, Pa.; S. T. Williams, Superintendent Otis Iron and Steel Co., of Cleveland, Ohio; Jerome Wheelock, of Worcester, Mass.; M. N. Forney, of the Railroad Gazette, and others.

Respectfully submitted.

R. H. BRIGGS, *Chairman.*

THE PRESIDENT—I must congratulate Mr. Briggs on being, I believe, the only chairman of a committee who carried out in a strictly constitutional way the recommendations of our last meeting, which was that committee reports be printed before the opening of our Convention. I presume you have all read the report and are prepared to act upon and discuss it intelligently.

Mr. BRIGGS, Mobile & Ohio Railroad—Perhaps it is due to the gentlemen present to state that that report was gotten up under great difficulties on my part. When I accepted the position of chairman of that committee I supposed, as a matter of course, that I would have a body of intelligent men to co-operate with me as members of the same committee; but, very unfortunately for myself, after I had gone home I found that I was not only chairman but the whole committee; but, as I state here, I found hearty co-operation whenever I called upon those who were supposed to know the actual necessities of the case. I have been in this country now about forty-eight years, and I naturally feel proud of the United States; but I was, undoubtedly, the most surprised man you ever saw when I found that we did not have any positive measurement in this country by which metal workmen could be so guided as to fill an order exactly when called upon. Every man whom I applied to confessed his inability to fill an order exactly. They all had a certain series of gauges that would measure to suit them, but not anybody else. I assure you, gentlemen, that this matter has given me a great deal of thought; and I tell you that you do need what I recommend, a Standard American Gauge. I hope that what I have done will meet with your approval.

Mr. FRY, New York, West Shore & Buffalo Railroad—If I understand the recommendation right it is simply this: That in specifying sheet or wire

we state exactly what we want. If we want half an inch thick we say half an inch thick, and so on; and there is no room for doubt as to whether we mean Birmingham Wire Gauge or Stubbs' Wire Gauge or some other wire gauge. Unless some gentleman can show us that there are differences that can not be measured, or that there is some insuperable objection to ordering metal in that way, the good, sound common sense of the recommendation is such as I think will commend itself to us all, and there will be little difficulty in getting the Association to support a motion to adopt the recommendation of the Committee.

Mr. FLYNN, Western & Atlantic Railroad—We all know the difficulties that have existed for many years, owing to the multiplicity of gauges that exist in this country. In some cases where we have ordered iron, and found when we received it that it was not right, the manufacturers have said: "We understood you wanted the Birmingham Gauge;" and when we have come to compare it with the Birmingham Gauge we have found it was not right by that. In many cases the persons furnishing the iron suppose that you have not got the Birmingham Gauge. I once gave a heavy order for all grades of iron to the Hillman Works in Tennessee. The iron came and none of it was correct, and there was about thirty-five hundred weight more metal in the iron than there would have been if it was right; I ordered it to the American Wire Gauge. Now I think it is essential that we adopt some gauge to be known as the American Standard Gauge. You can call it the American Micrometer Standard Gauge, or give it the name of this Association; but whatever the gauge is it ought to be well published to the American world at least, that that is the standard gauge of America; because if you do not so publish it that old system will still be in existence, and it is extremely necessary that we should get those engaged in the manufacture of sheet iron to recognize that as the standard gauge of this country. We will thus do away with the Stubbs' Wire Gauge, the Birmingham Wire Gauge and all those gauges, and adopt a system of measuring exactly the thickness you want the iron. The only thing I want to impress on the minds of the members of the Association is this, that such a course should be adopted as will make the gauge decided upon the standard gauge of the country.

Mr. HAYES, Illinois Central Railroad—Not having seen an instrument of this kind, I would ask the Chairman of the Committee if the scale is marked upon the screw so that we can get the exact thousandth part of an inch on that?

Mr. BRIGGS, Mobile & Ohio Railroad—Yes, sir. I will state for the gentleman's information that on the gauge is a little column upon which are divisions, and each division represents $\frac{25}{1000}$ of an inch, or $\frac{1}{40}$. On this standard is a little revolving cylinder on the bottom of which are divisions. You will find twenty-five divisions on that little cylinder. You turn that one division and that lifts the screw exactly the one-thousandth part of an inch. A person having a very good eye can turn up a half of that and get a most accurate

measurement of one two-thousandths of an inch, and so on less than that. It is as simple as can be; you can not make a mistake. You have a little set screw there which you can set to as fine a gauge as you want to work to. After a certain amount of wear has taken place the mode of adjustment is to bring the zero mark around to this line [indicating], and it is just as good after ten years ordinary use as it was the day you got it. I have an instrument in my valise, and will show it to the members who may wish to see it.

THE PRESIDENT—I would suggest that Mr. Briggs procure the instrument at once, in order that we may be able to dispose of this matter to-day.

Mr. FLYNN, Western & Atlantic Railroad—All I desire is that we have an American Standard Gauge, to be known as the standard gauge of the country. If the members of the Association think that this one is not suitable, why let another one be suggested. When we reflect upon the number of years we have been engaged in mechanical pursuits in this country, and think that we have had no standard gauge, it is something almost astonishing. A great many men in sending out orders simply say "wire gauge." Naturally the rolling-mill men will suppose it is the Birmingham Gauge, and it comes so. The beauty of this instrument, as I understand it, is that you just order your iron of the thickness you want it. If you want $\frac{1}{32}$ of an inch or $\frac{1}{64}$ of an inch, you order it so; you do not order No. 14 wire gauge or No. 13 wire gauge.

Mr. FRY, New York, West Shore & Buffalo Railroad—I suppose if we decide to order iron by measurement it would be at the option of the rolling mill to take any measuring machine they liked. If we ordered iron a thousandth of an inch thick, and the manufacture gave us iron a thousandth of an inch thick, it would make no difference whether he measured it by a two-foot rule or an ordinary gauge, if he could prove he gave us iron a thousandth of an inch thick; but if we know there is an accurate instrument easily obtainable, and we order our iron by measurement, we can then in case any misunderstandings spring up easily settle them, and it will be so much the better for the whole country.

Mr. WEST, New York, Lake Erie & Western Railroad—I would say that the Victor Manufacturing Company make a machine similar to the one spoken of, which costs one dollar less and has a capacity of an inch and a quarter.

Prof. SMITH, Washington University, St. Louis—I have had experience in ordering several thousand tons of plate iron. I soon learned that I had to order it by specifying the weight per square foot, telling them that I would not pay for any more. With regard to this, it is simply an accurate machine for getting the standard measure of the United States. It is not a gauge in the sense in which the word is applied to the Birmingham Wire Gauge.

Mr. JOHANN, Wabash, St Louis & Pacific Railroad—I understand that what we want is a standard gauge; this, so far as I can see, is merely a measuring machine. By the existing system when you order anything no-

body knows what you want. I think we ought to determine on a given gauge, and this instrument can still be used to measure iron with; but I do not see that in adopting this we adopt any particular gauge. This measures anywhere from a fractional part of a thousandth to half an inch or more. I understand that what we want to get is such an instrument as the American Gauge or the Birmingham Gauge or Stubbs' Gauge. If we adopt one gauge of that description the manufacturers will know what we want when we give an order. If when you purchase any sheet metal and have the suspicion that it is heavier or lighter than you ordered it, this instrument can be brought into play to test it; but I do not see that we will establish any gauge in adopting this. It is a measuring instrument, but not a gauge. What we want is to establish a gauge, and rule all other gauges out. If we decide to do that either one of those gauges will answer the purpose.

Mr. BRIGGS, Mobile & Ohio Railroad.—I am afraid that our friend has not read my report. In that report are shown the differences in the same gauges all over the country. One man may have a gauge that he uses twice a week; another may have a gauge of the same kind that he uses fifty times a day; how are you to prove which of those gauges is the true one? The object is to have something that is positive; let it be called a gauge, or a measure, or what you please. I tell you, gentlemen, that that is the only thing on the face of the earth, and I make the assertion advisedly, that can be relied upon as a positive measurement every time. I know that this Convention can honor itself by adopting that gauge, and I recommend it with the greatest confidence.

A MEMBER—Only last week I was ordering some copper to place around some flues. I ordered sixteen copper, and it went into my gauge easily at eighteen. Mine was a comparatively new gauge, and theirs was a gauge which they had been using in the store for iron and copper and wire for fifteen or twenty years, probably. They were both Stubbs' gauges. Probably the sizes between 16 and 18 were the ones that had been used the most.

Mr. JOHANN, Wabash, St. Louis & Pacific Railroad—In reply to Mr. Briggs, I do not dispute his argument in the least; but, at the same time, I fail to see how this will establish any particular gauge. Whenever these gauges we are speaking about are worn, why then they are not gauges, or if gauges of the same kind are made by two different parties, and they are not made accurately, why they are not accurate gauges. In such a case that instrument can be used to test those gauges. You have the same trouble with your standard screw threads. A great deal of labor has been bestowed upon them; yet no two men will make taps precisely alike. What we want to do is to establish a gauge so that manufacturers will know what we want when we give an order.

Mr. SETCHEL, Kentucky Central Railroad—I do not understand Mr. Johann's argument. It seems to me that a gauge is simply for measurement. The trouble is that No. 2 Stubbs' Guage is not No. 2 Bir-

mingham Guage; but a thousandth part of an inch is a thousandth part of an inch. Now, as I understand it, the steel manufacturers and the iron manufacturers have especially recommended, in their letters, to Mr. Briggs that that kind of a gauge be adopted. It seems to me that to adopt any particular gauge leaves the matter where it was before. The gauges may not be right; but the thousandth part of an inch, as I said, is the thousandth part of an inch, and if we say to a manufacturer that we want a piece of sheet a thousandth part of an inch, it must come that way. We simply say we will adopt that as a unit of measurement, and order by it, and that settles the matter for all time. I agree with Mr. Briggs that if this Association does that, and sticks to it, that it will cover itself with glory. There will be no getting around it on the part of manufacturers. We say to them, "We want a sheet of iron, of a certain thickness, measured by Sharpe's Gauge," and we do not care how they measure it. They can measure it by Stubbs' Gauge, if they like; but if it is not of the right measurement by Sharpe's Gauge we will not have it.

Prof. SMITH, Washington University, St. Louis—What I said before was not intended in any way to be a speech against this gauge or this measuring apparatus, because it is the only way in which you can get good work; but simply as to the meaning of the word gauge, that was all.

THE PRESIDENT—Perhaps it would be well to make a little explanation of this instrument. I agree with Professor Smith thoroughly, that this does not establish a gauge. At the same time, I believe, as Mr. Setchel does, that we better establish this system of ordering iron, and insist that the iron be measured by some suitable instrument that is accurate. Now here is an instrument which I find, on examination, is self-adjusting, practically. I inquire: How are you going to know when this gets worn? I find that the moment it wears in the slightest degree these lines will not correspond until they are adjusted. I think, as Mr. Setchel has so forcibly said, that this Association should adopt some system. It is not adopting a gauge in one sense in adopting this, but adopting a system of ordering plate; and the system that this Committee has recommended, is, I believe, the correct one.

Mr. BRIGGS, Mobile & Ohio Railroad—I do not want it to be understood that I would advise that this Association should dictate to the manufacturers of the United States that they shall use that as a gauge—not by any means; but I do want it understood that we will not accept any other measurements but that. They can use a Stubbs' Gauge, or Standard American Gauge, or any thing that they choose, but it has got to conform to our check every time.

Mr. JOHANN, Wabash & St. Louis Railroad—That is just the point I am making. I have no objection to changing the system of ordering; but we certainly do not establish any gauge when we establish this instrument to measure by. If you change the system of ordering, it lets us all out. It leaves Mr. Briggs right, and it leaves me right, too.

THE PRESIDENT—As far as I can see both the gentlemen agree, except in the matter of terms. I agree with Mr. Johann that this makes no change of gauge. I do believe in changing this system of measurements, and here is an instrument that makes that possible.

Mr. FRY, New York, West Shore & Buffalo Railroad—I should like to propose that it be the sense of the Association to abolish the system of ordering by gauges, and adopt the system of ordering by measurement in plate wire and other articles that we have been accustomed to use gauges for heretofore.

Mr. SETCHEL, Kentucky Central Railroad—I move that the recommendation of the Committee be accepted and adopted by this Association.

The motion was carried.

Mr. FRY, New York, West Shore & Buffalo Railroad—While I was at Philadelphia, at the Master Car Builders' Convention, the question of screw threads was brought up, and there is a gentleman present—Mr. Bond—who was also at that convention, who has some standards of screw threads, and can show us how definite standards of screw threads can be maintained. If that subject can be brought before the Association in any way, it would be of very great interest and of permanent value to us to understand thoroughly the status of the question as it is to-day.

THE PRESIDENT—I would suggest to the Association that the gentleman be allowed to bring in his gauges and exhibit them to us to-morrow mornng. Before the session there will be ample time for all the members to examine the gauges.

The Convention then adjourned till the following day.

THIRD DAYS' PROCEEDINGS.

The Convention was called to order at 10 A. M.

The President stated that an invitation had been extended to the Association by the New York, Lake Erie & Western Railroad to go on an excursion the following day to the Portage Viaduct.

On motion of Mr. Raymond, of Chicago, Illinois, the invitation was accepted, and the Chair was instructed to appoint a committee to ascertain how many of the members intended to avail themselves of the invitation.

THE PRESIDENT—If there is nothing further to be said on this question, we will pass to the next subject. The next business in order will be the reading of a paper presented to us by Mr. P. H. Dudley.

The Secretary then read the following paper:

Paper of P. H. Dudley.

To the American Railway Master Mechanics' Association:

GENTLEMEN—The practical performance of the American Fast Express Locomotive of to-day far exceeds what was thought possible ten years since, and we know from experience that the improvements you are constantly making will increase its speed for heavy trains.

If the data in regard to fast ten and twelve-car trains were all collected it would leave no doubt as to the ability to run them at fifty miles per hour, on nearly level roads, or five and six cars at sixty miles.

Having drawn with my dynagraph car fast express trains upon various roads, I present a brief tabulation of part of a trip, showing the performance of an ordinary locomotive upon a train composed of three 8-wheel and six 12-wheel cars; weight 250 tons. Total weight of locomotive, ready for the start, 126,000 pounds, distributed as follows: Tender, 54,000 pounds; engine, 72,000 pounds, 48,000 pounds being upon the drivers, which were six feet in diameter; cylinders, 17 by 24; steam pressure gauge set at 135 pounds.

The 1st column shows the number of miles;

The 2d, the time of run in minutes and seconds;

The 3d, speed in miles per hour;

The 4th, velocity of the wind in miles per hour;

The 5th, approximate grades;

The 6th, foot pounds of work, shown by the dynametrical curve, in drawing the cars per mile;

The 7th, foot pounds per minute, expressed in horse power;

The 8th, approximate calculated foot-pounds of work required to move the locomotive itself, expressed in horse power.

The 9th, the sum of columns of 7th and 8th.

Column 8 will vary with every locomotive, and could only be determined by direct experiment.

In starting the train the locomotive would record a tension of 11,000 to 12,000 pounds for one or two hundred feet of distance; then, by hooking up the cut off and other causes, would reduce to 2,800 to 3,000 pounds, when the speed of fifty miles per hour was attained in the fifth mile. As the speed increases, the resistance of the air against the locomotive becomes greater, and more of its own power is required to move itself, and less can be used to draw the cars.

The increased foot pounds of work in the first four miles show less than one-half of that required to overcome the inertia of the train for the speed of fifty miles per hour. Inertia is an important element of train resistance, especially on local trains, as it limits the speed for short runs, and must be considered in choice of locomotive for the service. In starting a train the working adhesion of the steel-tired drivers, on dry steel rails, is usually above 33 per cent. of the weight upon them, and reduces as the speed increases; but in what ratio not ascertained by experiment. Eighteen to twenty per cent. has been obtained at 56 miles per hour, the percentage of slip not exceeding $1\frac{1}{2}$ per cent.

The great and substantial improvement in the permanent way, of late years, permits a higher percentage of adhesion than formerly.

One of the most important features shown in the tabulations is the quick steam generating capacity of the boiler: 800, 900, or 1,000 horse power developed in the brief time of one minute may be expressed in figures; but the mind fails to gain any adequate conception of the enormous power. At a 135 pounds steam pressure, 300 or 333 pounds of water will be evaporated per minute with a consumption of 40 or 50 pounds of coal. This requires a very rapid generation of heat, and its quick absorption by the water.

Owing to the large amount of heat which is absorbed by the

water before it makes any pressure of steam, a less proportion of heat units are required to do the work at high pressure than low, therefore the rate of transmission per minute will be less for the heating surfaces.

The Swiss and German locomotives are reported to carry from 165 to 180 pounds pressure, as a rule, with exceptional ones at 225.

In drawing fast and heavy trains on various roads the greatest difficulty in making time has been want of steam. There are so many contingencies which may daily arise, of winds, storms, etc., that provision must be made for a greater capacity than is required for ordinary occasions. In observing what the train resistances would be for the above-mentioned train—about 11 pounds per ton—it must not be concluded that this would also be true of any other weight of train; the resistance of the same number and class of cars increases in same ratio as the speed increases; and as we increase the tonnage number of cars, the amount per ton decreases.

Another important element of train resistance is the condition of the track—having upon my instrument apparatus for mechanically determining the condition of the track—it is found, even on the best roads, each mile can not be in equal condition, owing to increased wear and quality of rail. On grades it is especially the case, and at stations where many trains stop and start. Experiments upon all classes of passenger trains are too limited to give any reliable formulas for general use. For long and heavy trains I have found the resistance per ton much less than that given by the latest formulas.

Yours truly,

P. H. DUDLEY.

TABULATION OF PART OF A TRIP OF THE DYNAGRAPH CAR ON A FAST EXPRESS TRAIN.

1	2	3	4	5	6	7	8	9
Numbers of Miles......	Time in Minutes and Seconds per Mile....	Speed in Miles per Hour..................	Velocity of the Wind in Miles per Hour......	Approximate Grades...	Foot Pounds of Work shown by Dynametrical Curve per Mile	Foot Pounds of Work per Minute expressed in Horse Power...	Approximate calculated Foot Pounds of Work required to move the Locomotive in Horse Power	Sum of Columns 7 & 8
1	2:54	20.68	....	Level	24,116,233	252	....	......
2	1:34	38.31	6.	Down 5 ft 3 in	20,035,253	369	221	590
3	1:22	43.90	4.	Down 5 ft 3 in	17,763,214	398	292	690
4	1:16	47.34	3.	Level..........	15,904 273	383	418	791
5	1:11	50.70	4.5	Level..........	14,871,528	382	406	788
6	1:13	49.31	6.	Up 13 feet. ..	15,284,616	383	406	789
7	1:11	50.70	6.	Down 18 feet	14,458,430	369	426	795
8	1:08	52.89	5.	Down 13 feet	13,219,136	354	451	805
9	1:07	53.70	5.	Down 8 feet..	11,566.744	319	483	802
10	1:09	52.10	5.	Down 5 feet..	11,773,293	310	441	751
11	1:08	52.89	4 2	Level	11,773,293	316	447	763
12	1:09	52.10	5.2	Down 8 feet..	12,806,038	337	456	793
13	1:10	51.43	6.	Level	12,392 940	324	443	767
14	1:10	51.43	4.5	Level	12.806,038	339	426	765
15	1:10	51.43	4.	Level	13,425,685	351	420	771
16	1:10	51.43	3.5	Level	13,299,136	345	415	760
17	1:08	52.89	3.	Level	13 838 783	371	443	814
18	1:08	52.89	5.	Down 6 feet..	13 219,136	354	464	818
19	1:08	52 89	3.	Down 2 feet..	13,219,136	354	443	797
20	1:11	50.70	3.5	Up 10 feet ...	14,838 783	379	406	785
21	1:13	49.31	3.	Up 10 feet ...	14,458,430	362	384	746
22	1:08	52.89	3.1	Level	12,392,940	332	443	775
23	1:07	53.70	3.1	Down 10 feet	12,186,391	333	462	797

On motion of Mr. Woodcock, it was agreed that the paper of Mr. Dudley should be received and incorporated in the Annual Report.

The President—It has been suggested that the report read last evening on Improvements in Locomotive Construction, presented by Mr. Woodcock, might not have been heard by all the members; and, inasmuch as there are some drawings presented with the report, I would say that Mr. Strong and Mr. Paxson are both present, and will be very glad to answer any questions that members may care to ask in regard to the form of construction of the locomotives represented on the blackboard.

Mr. Woodcock, Central Railroad of New Jersey—We listened yesterday to a report on connecting rods and the breaking of them. One of the blue

prints there shows a coupling designed to remedy that evil. [Mr. Strong's design.] There might be some points in connection with the subject that the members would like to inquire into. The inventor is present, and he would be glad to answer any questions as to what his claims are as to this new departure; also in reference to the boiler. We are looking forward to carrying high pressures [Mr. Underwool's boiler], and we must, of necessity, arrange boilers to meet what we want I notice that that boiler [referring to Mr. Strong's designs] is made of cylindrical form; of course it must be a very strong design, and a departure from usual practice. In reference to getting heating surface on our locomotives, that has been accomplished by the plan of boiler adopted by the Philadelphia & Reading Railroad Company. All these gentlemen are present, and will, no doubt, give explanations of the workings of these plans to any who desire to hear about them.

A recess of five minutes was taken to enable members to examine the drawings.

The Chair appointed as a Canvassing Committee, to ascertain how many members desired to go on the excursion the following day, Messrs. William Fuller, H. N. Sprague and Allen Cook.

Mr. SETCHEL, Kentucky Central Railroad—There is one design mentioned among the improvements which, although I have heard it spoken of, I have never seen it on a locomotive, and I would like to inquire as to its value and durability—that is the steam-reverse gear for locomotives. I do not know anything about its working or its advantages. I believe there are members present who have had it in use, and I would like to hear from them.

Mr. FRY, New York, West Shore & Buffalo Railroad—I am like Mr. Setchel, and I would like to ask Mr. Paxson to give us his experience. I believe he has one of these gears in very successful operation.

Mr. PAXSON, Reading Railroad—We have some five of them in use. The first, I think, has been in use some twelve months, and there has been no trouble with it. We have two kinds; one that we use on passenger engines, with an oil cylinder for holding the lever in position. We also have one that was designed specially for shifting engines, of which there is a drawing here, I think. The advantage that we find is the perfect control which the engineer has at high speed. The one used for shifting engines was put on for the purpose of diminishing the labor of the engineer. It is working very satisfactorily.

Mr. FRY, New York, West Shore & Buffalo Railroad—One of the complaints made against the ordinary steam-reversing gear is, that it does not hold—it creeps forward or creeps backward.

Mr. PAXSON, Reading Railroad—We have had no such trouble. I understand the Pennsylvania had some trouble with creeping. On this one, for shifting engines, the link can creep about $\frac{3}{16}$ of an inch. It will creep down

and the steam will catch it, and it will creep back. The oil cylinder holds it perfectly firm.

Mr. LYNE, American Machinist—Last spring I investigated the steam reverse to some extent. I took a ride on some of the Pennsylvania engines, and also one on the New Jersey Central Railroad. The steam reverse used on the Pennsylvania Railroad I found to consist of two horizontal cylinders, the forward one for oil and the back one for steam. Both pistons were connected to the same rod, and were extended out and joined with the usual connection to the lifting shaft. I found that the link would not hold its position; when the piston was drawn back to lift the link to the required position and steam was shut off the link would drop. I found that was due to the use of leather packing in the oil cylinder, and the engineer had to put in a block to hold the link in position, consequently it could not be varied with the nicety with which it ought to be with such a device. On the New Jersey Central Railroad, instead of using leather packing in the oil cylinder, they use asbestos, which works with much better results, and is much more precise, so that the link can be adjusted at any point and left there; but there is this difficulty, as soon as there is the least leakage of course air passes into the oil cylinder so that it will form a cushion. Now, for my part, I can not see the object of a steam reverse. I see but this advantage in it, which is the advantage of cutting off at any desired point without placing the lever in a notch. It strikes me that it is a very expensive arrangement to accomplish this result. I have heard it said that owing to the increase of pressure in the boiler, the increase in the size of the valves and the area of ports, and the size of cylinders, that it is too hard work for the engineer to move the lever. Another thing is complained of very much—the increase of these ports and the pressures, of course, makes valve seats and valves wear away very rapidly, and they become leaky. Now it strikes me that to apply steam reverse to move the valves, because the engineer can not move them with a lever, is beginning at the wrong end. It seems to me that the proper way to do would be to remove a portion of the load from the valve. I do not know that it is necessary to balance a valve; but, for instance, there is 8¼ tons pressure on the valve, and you remove seven tons of that load, then you can increase the bearing surface upon the links and upon the different connections which go to make the valve motion wear longer, and allow the engineer to move his lever to any desired position. I was permitted to ride upon an engine which was built by Mr. Underhill, for carrying a pressure of 160 or 175 pounds to the square inch, and it was claimed to be impossible to use a valve that was not relieved of its load; and I found upon that engine that the engineer could move the lever with one hand to any desired position in the quadrant. A member of this Association, who is not present today, has, I understand, a device which consists of an oil cylinder attached to the end of the reach rod, and the valve upon this cylinder is connected with the usual latch upon the lever, so that when the latch is depressed, in-

stead of raising the latch out of the quadrant, it opens the valve in this oil cylinder, and the lever can be moved to any position desired, and left there locked, substantially as in the case of the steam reverse. This device costs less and is less liable to derangement, and accomplishes all that the steam reverse accomplishes. It seems to me that the small advantages of the steam reverse will hardly pay for the cost of its construction when there are so much more simple devices. I think that one of the most important considerations in constructing high speed locomotives is the elimination of all possible friction, and it is well known that the least derangement in the valve gear of a locomotive is attended with waste of fuel; and I think when valves are once set properly they ought to remain so for a year, at least, without being changed. I have known cases where an alteration of the thickness of a piece of tin would make an apparent difference in the operation of the locomotive; and when so slight a variation as that will make such a difference, I think it is highly important that we should study every possible way of arranging the valve motion and relieving the valve, so that it will be less liable to derangement.

Mr. SETCHEL, Kentucky Central Railroad—I would like to hear from Mr. Strong, who, I believe, has that double connecting rod. [Engine design.]

Mr. STRONG—The first idea of getting rid of the connecting rod suggested itself to me last summer in England. When I was there, there was a great deal of talk about Webb's compound engine, and one of the principles which are supposed to exist in the construction of that engine is the possibility of doing away with the side rods. In England, and on the continent, most of their express engines, running at sixty to seventy miles an hour, are single drivers, and governments on the continent are more particular than our government is in regard to accidents. The idea that suggested itself to me was to couple direct and do away with the throwing action—the downward and upward parallel motions of the rods. I claim, among the advantages of this that we have greater freedom of action on the drivers, aside from the downward throw, on account of each rod being independent of the other in its motion. It is on these western roads, where the track is rough, that the most rods are broken, on account of the sudden downward throw of one wheel, while the other wheel, perhaps, is thrown up, and at a point where it takes a peculiar angular action on the rod. Our rods are always acting at the same angles on both wheels at once, and the action on this rod is a straight parallel motion without any throw. I shall be pleased to answer any questions that may be asked in reference to this.

Mr. HAYES, Illinois Central Railroad—I would like to hear from Mr. Strong in regard to his boiler, if he will explain it. It seems to be an entirely new departure from the ordinary way of building boilers.

Mr. STRONG—This idea of getting a boiler free from stays is one that was brought to my attention last summer. Mr. Wetzel, the engineer of

the Austrian State Railways, had constructed a boiler with a flat side. The outside of the boiler was not different from the outside of any other boiler; but he had done away with the crown sheet, and put in an upper chamber and connected that on the regular fire box below. He had a square fire box below, and he had put in enough stays to hold up this upper chamber, and had done away with about half the stays in the boiler; that is had put a greater distance between the stays; he did away with the crown bar. I thought Mr. Wetzel's boiler was a very good one, and I got control of it in this country. I have carried the idea a little farther; I wanted to get rid of the stays entirely. To get a combination of the air and gases after leaving the fire chamber, I bring my neck connecting the fire chamber and combustion chamber well forward; and at this point [indicating] put in a jaw with a valve on the outside to regulate the amount of air that is admitted, allowing enough time in this chamber to give thorough combustion, and varying the length of the chamber with the kind of coal I have to use. If I have very heavy bituminous coal with a great deal of carbon in it, I only suggest the idea, I bring this combustion chamber well forward. I find on a great many western roads that some of the tubes do not run more than half way over the road before they are clogged with soot. Besides getting rid of the stays I claim another advantage, and that it gives freedom of action of the heating surface from the shell.. There is no action between the heating surface of the boiler and the shell except on the heads.

On motion, the discussion of the subject was then closed.

The Committee on Subjects presented the following report:

Report of Committee on Subjects.

To the American Railway Master Mechanics' Association:

Your Committee, appointed on Subjects for the ensuing year, beg leave to report the following:

COMMITTEE OF RESEARCH.

Improvement of Boiler Construction—Continued.

COMMITTEE OF INVESTIGATION.

1st. Is the Extension of the Smoke Box in Locomotive Engines Beneficial, and if so, to what Extent?

2d. In what Part of a Locomotive Boiler should the Check Valves be Placed, either for Pump or Injector, to Produce the Best Results?

3d. New Plan of Construction and Improvements of Locomotive Engines—Continued.

4th. The Most Practicable and Best System of Paying Premiums to Locomotive Engineers and Firemen to Induce Economy in Working Locomotive Engines—Continued.

5th. Standard Reamer for all Bolts used in Locomotive Work, the proper Taper or Angle to make them, and a System of Gauges to Correct and Maintain a Standard when Worn?

6th. Is it Best to Cone or Taper Driving Wheel Tires, if so, to what Extent?

JACOB JOHANN,
JAMES BOON,
JOHN H. FLYNN, } *Committee.*

On motion, the report was received.

The Secretary presented the Report of the Committee on Conference with the Master Car Builders, which was read and received.

Report of Committee on Conference with the Master Car Builders.

To the American Railway Master Mechanics' Association:

Your Committee appointed to confer with a Committee appointed from the Master Car Builders' Association for discussing of the desirability of holding joint meetings of the two Associations. beg leave to report:

That the joint committee considered it desirable for the interests of the two societies to have their meetings held upon the same days and in the same place, and to that end recommend that a committee of three be appointed at the next annual meetings of the two Associations, with authority to decide upon a place of meeting, and to make the necesary arrangements for the meeting for the year 1883; and we would also recommend that said committee designate one of the following cities as the place for the meetings for the year 1883:

Saratoga, Niagara Falls, Indianapolis, Pittsburgh, or Chicago.

We also recommend that the second Tuesday in June be the time set for holding said meeting.

Respectfully,

F. M. WILDER,
JAS. SEDGLEY,
WM. WOODCOCK, } *Committee.*

Mr. RAYMOND, Western Railroad Association—There was some difference of opinion among the members of the Master Car Builders' Association as to the proper course to pursue in the premises, and they deferred any action until their October meeting. They are to have a special convention—the first of their representative conventions—at this place, in October next. I therefore think that it might be impolitic for this Association to take final action in advance of the action of the Master Car Builders' Association, and I would move that the report of this Committee be referred to our Supervisory Committee with power to act. Let them confer with the other Committee at the Committee meeting.

The motion was seconded.

Mr. SPRAGUE expressed himself as not in favor of giving the Supervisory Committee power to select the place of meeting. He thought the Committee should be given more definite instructions. He was opposed to holding the meetings of the Association at watering places. He thought a large manufacturing city would be more suitable.

Mr. FRY said that the Association had grown so rapidly that there were very few large cities which could afford suitable hotel accommodations for its meetings; but at the watering places, at this season of the year, the hotels are just opened, and the proprietors are glad to have a chance of welcoming so large a number of guests. If the Association should meet in New York, or some other large city, all the members could not find accommodation in one hotel. It would be noticed that most of the large meetings of scientific and other bodies are held at places where all the members can be accommodated at the same hotel.

Mr. SPRAGUE said that he questioned whether the Convention was not depriving itself of the presence of the most earnest members of the Association, who did not care to stop at a watering place and simply have a good time without reference to the work of the Convention.

Mr. FLYNN, Western & Atlantic Railroad—I feel that the Supervisory Committee will study the interests of the Association as much as the individual members, and I think our friend is a little mistaken in supposing that we lose by going to watering places. This is the largest convention, I think, we have yet had. If we can increase our attendance by going to a watering place, I think we should do so. The Master Car Builders' Association has seen fit to defer action on this matter until their October meeting; and for us to designate a place now would be almost tantamount to saying we will pay no attention to them. Not that I desire we should seek an affiliation, I am perfectly willing to stand alone; but still a proper degree of respect is due to them. This gives them an opportunity to act, and if they do act, it gives the Supervisory Committee an opportunity to act in selecting the place which would be most acceptable to them.

Mr. RAYMOND, Western Railroad Association—It is perfectly plain to my

mind that the only thing we can do with any propriety now, in view of the relations of the two Associations, and in view of what the Master Car Builders have done, is to refer the matter to the Supervisory Committee. The matter of place is a matter of minor importance in my judgment. There is another bearing which the question has, which I desire to suggest without provoking any discussion, for I think a discussion of the subject would now be unfortunate perhaps. The central part of this whole plan is that the Master Car Builders and the Master Mechanics shall meet at the same time and in the same place. To that there are serious objections. The other plan is to follow out the plan of this year; to have the Master Car Builders meet in one city one week and the Master Mechanics to meet the following week in another city, the two cities to be near enough together to enable members to go from one to the other in a night. My own judgment is very strongly in favor of that plan.

The motion was carried.

Mr. HOLLISTER, of the Valley Railroad, presented the following question for discussion: Is it Best to Taper or Cone Driving Wheel Tires, and if it is Best to Cone them, to what Extent?

On motion of Mr. FLYNN, it was agreed to refer this question to the Committee on Subjects.

Mr. BRIGGS, of the Mobile & Ohio Railroad, presented the following question: Is the Use of Metallic Packing for Piston Rods and Valve Stems Desirable?

On motion of Mr. BRIGGS, this question was referred to the Committee on Subjects.

Mr. PETER CLARK, of the Northern Railroad of Canada, presented the following question: What is the Best Form of Cone for Diamond Smoke Stacks?

Mr. CLARK, Northern Railroad of Canada—I have lately been trying an experiment with a new form of cone—it is a series of cast-iron rings. Some of the other members may have tried the same thing. I have tested it, and so far it has given very good results. I have corrugated the under side of the rings. It is a kind of cone formed by rings diminishing in diameter, say about six rings, and, of course, they form a kind of pyramid or cone. I find that the ashes are eliminated with this cone and that the steam is very free, and altogether the stack is giving very good results. I brought the subject up more to see if any of the other members had used anything of the kind and what results they had got from it. I shall be very glad to submit tracings of it to the Secretary at any time. I saw something of the kind on the Grand Trunk and changed it to the form I described. There is no patent on it at all, anybody is free to use it.

Mr. HOWARD FRY, of the New York, West Shore & Buffalo Railroad,

presented the following question: What Lubricant is Best for Locomotive Cylinders, and how much Lubricant per Mile should a Locomotive Use for all Purposes?

Mr. FRY, New York, West Shore & Buffalo Railroad—The lubrication of the cylinders of a locomotive affects very materially the amount of lubrication that is used altogether, the cylinders taking a very large proportion of the total amount necessary for the whole engine. There has been a good deal of experimenting lately to get a material that shall not eat away the cylinders, and some hopeful experiments have been made with some of the heavier qualities of black oil. A short time ago, in looking over some reports of the Lake Shore Railroad, I noticed that one particular division was materially lower in its consumption of lubricants not only than any other division of that railroad but than any division of any other railroad I am acquainted with. It seemed to me very remarkable that a division of the Lake Shore, which is one of the most dusty roads that I know of, should have so greatly reduced the consumption of oil for locomotives. It argues either that they use a much better material than we do, or else that they have given a great deal more attention to the subject. Some time afterward I was on that road again, and I took the liberty of talking with some of the subordinates. I learned that the master mechanic of that division had made a hobby of that subject, and some of his friends, I believe, laughed at him for doing so. It seems to me that it would be a good thing if a good many of us would make hobbies of things of that kind. I think a pint of lubricant was consumed per 26 miles, including tallow and oil and everything else; I think there may be some interesting facts developed if we could ascertain what means were taken to reduce consumption to the very low point they have attained.

Mr. SEDGLEY, Lake Shore & Michigan Southern Railroad—Mr. Fry has referred to our road; I would simply state that we are using a treated oil for lubricating our locomotives, and I do not think we are doing as well as we ought to do. I am free to confess that. Mr. Fry referred to our Erie Division where the mileage perhaps was 26 or 27 miles to the pint. As is well known by all who pass over that division, it is a very hard division to lubricate; but it simply shows what can be done if you give attention to a thing. This division, four or five years ago, was making perhaps 9 or 10 miles to the pint of oil, and the thing was apparently so far out of the way that attention was called to the matter, and by close application and by talking to the men they gradually brought the mileage up without any detriment to the engine. In fact it is a benefit to the engine. I will say, for the information of the members, that our mileage was $20\frac{55}{100}$ to the pint of oil last year, which was below the average; it was a very severe year and we were double tracking a large portion of the road. That means extreme service, and the cost per mile run, for lubricating our engines in 1881, was one-fourth of one cent per mile. We use nothing but the earth oil; I would qualify that by stating that I presume there is

a mixture of animal oil in the cylinder; but we use a treated oil. We have been using it for some four or five years, and we use nothing else. I attribute our success very largely to that. The men know what they are using. It is not water to-day, or oil to-day and water to-morrow, as was the case when we were using every-body's oil. There was a time when, if a man said that he had a good thing, we would take it and put it on the engine; but we have got past that. My own judgment is that we ought to make 25 miles to the pint of oil. The cost of the oil we use is $5\frac{18}{100}$ cents per pint.

Mr. HAYES, Illinois Central Railroad—Does that include oil used in your headlights, lamps, etc.?

Mr. SEDGLEY, Lake Shore & Michigan Southern Railroad—It does not; I simply take the lubricating oils.

Mr. HAYES, Illinois Central Railroad—I would state that for the last two or three years our oil has cost us 30 cents to the 100 miles. That includes all the oil—the headlight, cab lamps, lamp of the engineer and fireman, and signal light, when they carry one. Our average for lubrication is over 25 miles to the pint, leaving the lamp oil and signal oil out of the question.

Mr. CLARK, Northern Railroad of Canada—My experience has been much the same as Mr. Hayes' as to the cost of our oil. My cost is about .33 to the 100 miles. For the lubrication of cylinders I have tried several cylinder oils, and never yet have I been able to get one to give the same results as tallow. Of course there are drawbacks to it; but, taking it all in all, I still prefer tallow. I think it gives the best results. Of the tallow, we use 4 pounds to 200 miles. When I speak of .33, that includes the same as Mr. Hayes' figures; the oil for headlight, lamps, and every thing else.

Mr. FRY, New York, West Shore & Buffalo Railroad—The figures mentioned by Mr. Clark seem to me to be about the average of most roads.

Mr. SETCHEL, Kentucky Central Railroad—I understand that Mr. Sedgley uses the same kind of oil for lubricating as he does in his cylinders.

Mr. SEDGLEY, Lake Shore & Michigan Southern Railroad—No, we use a different oil.

Mr. CLARK, Northern Railroad of Canada—May I ask Mr. Sedgley what his cylinder oil costs him?

Mr. SEDGLEY, Lake Shore & Michigan Southern Railroad—I should state from recollection, perhaps in the neighborhood of 45 cents per gallon.

Mr. HAYES, Illinois Central Railroad—I would like to ask Mr. Sedgley about what is his average mileage per pint of cylinder oil?

Mr. SEDGLEY, Lake Shore & Michigan Southern Railroad—I can not answer that question, because in making up the statement they were both put together, and I could only approximate it. I simply give you the aggregate cost of lubricating the engine including the cylinder.

Mr. HAYES, Illinois Central Railroad—I am using the same brand of oil as you are, and our average is about 60 miles to the pint for cylinders;

some of our men will run as high as 100. Taking the whole road it is about 60 miles to the pint for cylinder oil. It is a composition, as I understand it, of neats-foot oil and this common oil. I don't know what the proportions are; but we pay 58 cents a gallon for it, delivered in Chicago, and we find it gives better satisfaction than the tallow. After experimenting with it for about six months we adopted it for the whole line, and have been using it ever since.

Mr. WILDER, New York, Lake Erie & Western Railroad—How does it compare in the matter of economy with tallow or any other lubricant for the cylinders which you have used?

Mr. HAYES, Illinois Central Railroad—It costs about the same per mile as the tallow; but we get rid of the eating away of the cylinder faces and of the steam chest plates. After using it about a week we found a great deal of black sediment coming around the valve stem, and when we got that once cleaned off it made a polished surface; and since that our valve faces are perfectly clean and as bright as a new silver dollar, and keep so all the time.

THE PRESIDENT—I might say a word, perhaps, on this subject for the benefit of any one who is still using tallow, and may think of changing to one of these oils—the oil used on the Lake Shore and Illinois Central, for instance. I have been using it myself for a number of years, and it will invariably be found that this oil attacks the gum and other deposits left by the tallow or lard oil, that have been accumulating in the cracks and corners, in the ports, and all about the cylinders and steam chests, and cleans them out; and until they are cleaned out there will be a good deal of grinding and groaning and rattling of the lever.

Mr. SHORT, Canada Southern Railroad—After two years' experience with the oil Mr. Sedgley recommended, we used the same on the Canada Southern. Our expenses are, of course, heavier on the other side of the line, because we have to pay 20 per cent. duty to get these oils across the border. Our mileage last month was 72.5.

Mr. BRIGGS, Mobile & Ohio Railroad—In view of the shortness of the time at our disposal, I move that this discussion be closed, and that no more miscellaneous business be taken up, and that we proceed with the regular order.

THE PRESIDENT—I have still another question which, perhaps, I ought to read, viz.: Is there any More Reliable and Simple Method of Ascertaining the Actual Working Condition of Locomotives than by the Application of the Steam Engine Indicator? The question is presented by Mr Lyne. I would suggest that inasmuch as this is introduced by one of our associate members, that we ask him to furnish us a paper, to be read at our next Convention, on the steam engine indicator.

Mr. WILDER, New York, Lake Erie & Western Railroad—I was just going to make that suggestion.

The President's suggestion was, on motion, agreed to, and the motion of Mr. Briggs was renewed and carried.

The Committee on Associate Membership reported favorably on the application of Mr. Willard A. Smith, of the Railway Review, to be admitted as an associate member.

THE PRESIDENT—Prepare your ballots, gentlemen, for a vote upon the candidate named in the report. I will appoint as tellers Mr. F. M. Wilder and Mr. James Sedgley.

The balloting was then proceeded with, and the result was announced by the President, as follows: Whole number of votes cast, 39; necessary to a choice, 19. The candidate, Mr. Willard A. Smith, having the whole number of votes cast, is elected.

Mr. SPRAGUE, of H. K. Porter & Co.—I have felt for years that a committee on shop tools and machinery would be a very necessary thing for this organization; and I simply ask the members to think of this subject during the coming year, and see if it would not be proper next year to appoint such a committee, and help them make a report that would be of benefit to the Association.

Mr. WILDER, New York, Lake Erie & Western Railroad—I believe that matter has already been brought before the Committee on Subjects, and they have it under consideration.

It was agreed, on motion, that a Committee on Resolutions should be appointed. The Chair appointed as such committee: Lewis F. Lyne, of the American Machinist; Prof. Smith, of Washington University, and Willard A. Smith, of the Railway Review.

The following resolution, proposed by Mr. F. M. Wilder, was adopted:

Resolved, That the Supervisory Committee be and they are hereby instructed to ascertain what steps are necessary to secure the incorporation of this Association, and report at our next annual meeting.

THE PRESIDENT—The next business in order is the election of officers.

Mr. HAYES, Illinois Central Railroad—I nominate Mr. Reuben Wells for President.

Mr. WILDER, New York, Lake Erie & Western Railroad—I second the motion, and, in seconding it, would like to add as an amendment that the Secretary be empowered to cast the ballot of the Association for Mr. Wells.

Mr. SPRAGUE, of H. K. Porter & Co.—I would like to inquire if it is probable Mr. Wells could be with us if we elected him President.

Mr. WILDER, New York, Lake Erie & Western Railroad—I would say, gentlemen, that I have made inquiries, and have the fullest confidence that, if we elect Mr. Wells he will serve, and we all know that he will serve to our satisfaction. I do not think that we will run any risk in electing him to the presidency of this Association.

The motion that the Secretary be empowered to cast the vote of the Association was carried, whereupon the Secretary cast the vote of the Association for Mr. Reuben Wells for President.

THE PRESIDENT—I have the honor to announce that Mr. WELLS is unanimously elected President of the Association for the ensuing year. The next business in order is the election of the First Vice-President.

Mr. WILDER, New York, Lake Erie & Western Railroad—I move that our present Second Vice-President, Mr. Sedgley be advanced to the position of First Vice-President, and that Mr. Setchel be requested to cast the vote of the Society.

The motion was seconded.

THE PRESIDENT—I would like now to say a word which I ought to have said before, but reasons which will suggest themselves to you all prevented me. I think I can safely say now, without being misunderstood, that I object to this way of electing officers. If I had said this while the election of a President was pending, somebody might have misunderstood my position. Again I must say that I object *in toto* to this way of electing our officers. I believe that in every instance every member should be allowed to vote, and the votes should be counted and the result declared, and the man having the majority should be our officer.

Mr. WILDER, New York, Lake Erie & Western Railroad—In making the motion in regard to Mr. Wells, I considered that his position in this Association was rather different from that of almost any other member. There has not been a Convention of this Association in which Mr. Wells' name does not appear upon some important committee, and he has always given us voluminous and valuable reports. He has been our Vice-President for three or four years, and I think the compliment was due to him.

Mr. FLYNN, Western & Atlantic Railroad—I do not see any objection to this mode of election. I think we are unanimous in our choice; I think it is due to Mr. Sedgley as well as to Mr. Wells to elect him in this way. It expedites business, and I am sure if any one had any objection materially to it they might vote against it without creating any feeling on the part of any other member.

Mr. SEDGLEY, Lake Shore & Michigan Southern Railroad—I agree with our worthy President in regard to the election of officers.

Mr. FLYNN, Western & Atlantic Railroad—You are an interested party; sit down.

Mr. SEDGLEY, Lake Shore & Michigan Southern Railroad—I believe it is due to the officers elected that there be a fair expression of the feeling of the Society.

Mr. RAYMOND, Western Railroad Association—It is customary where the majority is manifestly in favor of a candidate to empower the secretary of the society to cast the ballot; but it is, nevertheless, very bad policy to do

it except in extreme cases where you want to pay a very high compliment to one man. It is usual in some associations to move to defer the election of officers until the following year; and I think it is a very bad custom. I think this is a good time to commence regularly balloting for officers.

Mr. Wilder's motion was carried, and the Secretary cast the ballot of the Association for Mr. SEDGLEY for First Vice-President.

Mr. SEDGLEY—I am not unmindful of the compliment paid me, and I hope you will accept my sincere thanks. I consider it a very high compliment.

Mr. Howard Fry, Mr. William Woodcock, Mr. R. H. Briggs, Mr. F. M. Wilder and Mr. H. N. Sprague were nominated as candidates for the office of Second Vice-President.

Mr. Sprague declined to be a candidate.

The ballotting for Second Vice-President was then proceeded with and resulted as follows:

Whole number of votes cast 32; necessary for a choice 17.

For Mr Flynn	1
" Mr. Woodcock	2
" Mr. Wilder	7
" Mr. Briggs	2
" Mr. Fry	20

Mr. FRY was declared to be elected.

On motion of Mr. Wilder the election of Mr. Fry was made unanimous.

Mr. SPRAGUE, of H. K. Porter & Co.—I would nominate Mr. Setchel for Secretary. The affairs in his hands have been so smoothly conducted and with so little trouble that some of the members may think it will go just as well if we have somebody else; but when they come to think about it they will make up their minds that they can not get a better Secretary. I hope the members will vote unanimously for Mr. Setchel.

Mr. FLYNN, Western & Atlantic Railroad—I did intend to draw the line at the first two officers. Now I am strongly in favor of going back to the same mode by which we elected our President and First Vice-President. We all know that our Secretary has been, to a certain extent, the life of the Association; without such a Secretary I very much question if we would not be dragging on very feebly now; and with all due respect to the presiding officer of the Association, I look upon the secretaryship as the most important office here. Without an energetic Secretary the Association would soon retrograde in strength and efficiency. Mr. Setchel has stated that he does not desire the office of Secretary any more, I therefore offer this motion, that the Secretary be elected unanimously, and that the President cast the ballot of the Association.

The motion was carried, and the President cast the ballot of the Association for Mr. SETCHEL for Secretary for the ensuing year.

Mr. SETCHEL being called upon for a speech said: Mr. President and gentlemen, in writing out my report a few days before coming to this Convention, I wrote out what I considered was my resignation, unknown to any one except my secretary. Of course, when my term of service had expired then my term of office was out and a resignation would not be in order; and for the purpose of giving the members an opportunity to canvass the matter among themselves and select some one who would take the pains, as I stated in my letter, to familiarize himself with the business, so that matters would go on at least as well as they had been doing for the past twelve years; I took that way of informing you of what I thought to be my duty in the premises. I arrived at this conclusion from what had been stated to me at different times—sometimes it came from some traveling man, sometimes from a member of the Association—that perhaps we were getting into ruts, and that the Association should have new life and vigor infused into it. Feeling, to some extent, what my worthy friend Flynn has said, that the secretay is the life of the Association, I thought if we could get a real live man, with ability in him to take hold of this matter and push it to the utmost, that certainly now was a good time to do so, because I could retire feeling that I had done as well as I knew how, and that the affairs of the Association were in a creditable condition. If the incoming Secretary should succeed in doing better than I had done, there is no one who would have been more pleased to see it than myself. Talking with members here about the matter, they seemed very much opposed to my retiring, and I confess I was somewhat surprised, because I had thought that there was a desire for a change; and I am more surprised, Mr. President, by this unanimous action which has just taken place—and for this appreciation of what I have tried to do, gentlemen, I heartily thank you. We have had a very successful Convention, and we have had a very large attendance. This large attendance, the animated discussions we have had, the friendly faces we have not seen for years, the many beautiful wives and daughters of our members who have graced this gathering with their presence, make up a picture that will not soon fade from our minds. I hope, Mr. President and gentlemen, that you will take my proffered declination as I meant it, for the good of the Association only; and believe me when I say that in the future, as in the past, all that I can do for the interests of the Association shall be done.

THE PRESIDENT—(Addressing Mr. Fry who had just entered the room) I want to notify you of your election as Second Vice-President and to present my congratulations and to ask you to say a word to the Association.

Mr. FRY—Mr. President, allow me to express to you the great surprise that I feel on hearing the announcement which you have just made. I was informed that the election for Secretary was being considered, and although I was trying to hurry off my wife, who was about to leave upon the train, I said that I was particularly anxious to return to the meeting that I might say a word toward preventing any irreparable injury being done to the in-

terests of the Association by hasty action in regard to the secretaryship. I heard the concluding remarks of Mr. Setchel, and I am rejoiced to find (if I understood his remarks aright) that we are still to have our old Secretary. No one can feel more strongly than I do the value of the services that he has rendered to us, and to me it would have been a matter of very grave concern had we lost his services. The moment he sat down I rose to express those feelings. I find, however, that I am called upon to say something else, and that is to acknowledge my election as a Vice-President. It takes me so wholly by surprise that I can not give adequate expression to my feelings. I assure you that I regard an election to an office in this institution as one of the highest honors that can be paid to a mechanical engineer in this country. We have to follow in the steps of men who have, from the most unpromising beginnings, worked up this institution to its present very high standing. With very little encouragement from the railroads they served, and with very many promises of final failure, they have established the reputation of this Association on a world-wide basis. Those who are elected to fill offices in this Association have a weighty responsibility upon their shoulders; and I assure you, gentlemen, that I appreciate that responsibility and will endeavor, to the best of my ability, to carry out the policy which has been inaugurated. I thank you for electing me to this office and express my hearty appreciation of your kindness in so honoring me. (Applause.)

THE PRESIDENT—The next business in order is the election of a Treasurer.

Mr. WILDER, New York, Lake Erie & Western Railroad—Mr. Flynn has departed from his principles here two or three times, and I do not see any reason why we should not continue the same course in regard to the election of a Treasurer. I move that the Secretary be instructed to cast the vote of the Association for Mr. Hayes as Treasurer for the ensuing year.

The motion was carried, and the vote of the Association was cast by the Secretary accordingly.

THE PRESIDENT—I have the pleasure of announcing that you have unanimously elected Mr. HAYES Treasurer for the ensuing year. Mr. Hayes, we would like a speech.

Mr. HAYES—I am afraid you will not get much of a speech out of me; but I would like to state that I have served the Master Mechanics' Association since it was founded at Pittsburgh, fourteen years ago, and I had hoped that you would take some younger man, some one who would fill my place better than I have done; but since you have seen proper to elect me I can only return you my thanks.

On motion of Mr. Johann it was agreed that the question proposed by Mr. Clark, What is the Best Form of Cone for Diamond Smoke Stacks? should be referred to the Committee on Smoke Stacks and Spark Arresters instead of being referred to a new committee.

THE PRESIDENT—Now that I am on the eve of my retirement from the

presidency, I would like to say a word in relation to the business methods of the Association. We are inclined, I think, to give our subjects too much of a general character. For instance, the subject of which Mr. Woodcock has charge is a very general one to us; I think subjects more special in their character would be more interesting. "New Methods of Locomotive Construction"—why Mr. Woodcock has the range of the whole business; he has the locomotive from one end to another to report upon. I think that question should be divided up among several members; that is, in fact, what the Boiler Committee has done. That Committee, for several years, have divided their subject; that is one reason why we have such full and able reports on boiler construction. If the same thing were done with the subject of which Mr. Woodcock has charge it certainly would make much less labor for him and result in bringing out more information for the Society.

Mr. RAYMOND, Western Railroad Association—I desire to offer a single suggestion, that this Association, by a rising vote, tender its hearty thanks to Mr. LAUDER, our retiring President, for his zeal, attention and courtesy in the administration of his office for the past two years.

The Convention rose in compliance with Mr. Raymond's suggestion.

Mr. Wilder proposed three cheers for the retiring President, which were given.

THE PRESIDENT—I have only to say that I am grateful for this expression of your good will and esteem, and for the appreciation you have of my efforts in behalf of the Association. The duties of the President are not arduous except at our annual meetings. At our annual meetings there is some labor, I must say, in presiding and having things run smoothly, especially if there are any lawyers present to raise points of order. I am not much of a parliamentarian, and whenever a parliamentary question comes up I am very apt to put my foot in it; but I want to thank you all for your uniform courtesy to me while I have presided at your annual meetings. I never saw a body of men so willing to conform to anything that was necessary in order that our meetings should be conducted in a dignified way; and I thank you again for the expression of confidence you have just given to me by the vote you have taken.

The Committee on Resolutions presented the following report:

Report of Committee on Resolutions.

To the American Railway Master Mechanics' Association:

GENTLEMEN—We have witnessed with pleasure and satisfaction the growing interest and desire for investigation and advancement which has characterized this the Fifteenth and largest gathering for some years of our Association. We believe that no one will go away from this place without feeling that they can conscientiously

say that they have greatly profited by the proceedings of this meeting. The apartments selected for our accommodation could not have been more conveniently or pleasantly situated. The efforts put forth by our committees and friends have been eminently successful.

The honors done us by the Rev. J. S. Bacon, the pleasant entertainment given us, and the hospitality with which we were received by the proprietors of the International Hotel, together with the compliments of the gentlemen composing the entertainment committee are all sincerely appreciated.

We also feel very much honored by the complimentary excursion, so kindly tendered us by the New York, Lake Erie & Western Railroad Company, to Portage. Therefore be it

Resolved, That our sincere thanks are eminently due and are hereby tendered to all the parties to whom we owe the gratifying success of this Convention.

LOUIS F. LYNE.
CHARES A. SMITH,
WILLARD A. SMITH, } *Committee.*

The report was, on motion, received and ordered to be placed on file.

Mr. WOODCOCK, Central Railroad of New Jersey—I move that the compensation of our Secretary be made the same as last year.

Carried.

THE PRESIDENT—One other matter occurs to me now, which is a sad one; we have lost, within the past year, five of our members: ALEXANDER L. HOLLEY, W. S. HUDSON, WILLIAM RUSHTON, W. SPITTLE and H. E. WOODS. It will be necessary for this Association to take some appropriate action in this matter. I suppose a vote should be passed instructing the President to appoint committees to prepare a memorial for each of our friends that have gone, which can appear in the Annual Report.

On motion of Mr. Sprague it was agreed that the President should appoint such committees, and that their reports should be embodied in the Annual Report of the Association.

On motion of Mr. Sprague the Convention then adjourned, subject to the call of the Supervisory Committee through the Secretary.

Committees and Subjects for Discussion at the Sixteenth Annual Meeting.

1.

COMMITTEE OF RESEARCH.

Improvement in Boiler Construction.

JACOB JOHANN, W. & St. L. R. R.,
C. R. PEDDLE, T. H. & I. R. R.,
JAMES ECKFORD, C., H. & D. R. R.

2.

COMMITTEE OF INVESTIGATION.

New Plans of Construction and Improvement in Locomotive Engines.

W. WOODCOCK, Chairman, C. R. R. of N. J.

3.

The Most Practicable and Best System of Paying Premiums to Engineers and Firemen to Induce Economy in Working Locomotives.

F. M. WILDER, N. Y., L. E. & W. R. R.

4.

Smoke Stacks and Spark Arresters, to Include Best Form of Dome for Diamond Stack.

JAMES SEDGLY, L. S. & M. S. R. R.

5.

Is the Extension of the Smoke Stack Beneficial, and if so, to what Extent?

J. S. PATTERSON, C., I., St. L. & C. R. R.

6.

In what Part of the Boiler should the Check Valve be Placed either for Pump or Injector to Produce the Best Results?

T. B. TWOMBLY, C., R. I. & P. R. R.

7.

Is it Best to Cone or Taper Driving Wheel Tires, and if so, to what Extent?

J. D. HOLLISTER, S., F. & W. R. R.

8.

dard Reamer for all Bolts Used in Locomotive Work, the Proper Taper or Angle to Make Them, and a System of Gauges to Correct and Maintain a Standard when Worn.

COLEMAN SELLERS, Philadelphia, Pa.

9.

ciate Members to Read Papers.

L. F. LYNE, American Machinist,
F. W. DEAN, Harvard University.

10.

ding Committee on Subjects.

JAMES BOON, one year,
JNO. H. FLYNN, two years,
GEORGE RICHARDS, three years.

11.

e Use of Metallic Packing for Piston Rods and Valve Stems Desirable?

R. H. BRIGGS, M. & O. R. R.

12.

tees of the Boston Fund.

REUBEN WELLS,
JAMES SEDGLEY,
HOWARD FRY,
S. J. HAYES,
J. H. SETCHEL.

13.

ngements for the Next Annual Convention.

COMMITTEE TO BE APPOINTED.

lembers will be notified of place of meeting as soon as decided.—SECRETARY.

CONSTITUTION,

As Amended at the Fourteenth Annual Meeting, Providence, June 14, 1881.

PREAMBLE.

We, the undersigned Railway Master Mechanics, believe that the interests of the Companies by whom we are employed, may be advanced by the organization of an association which shall enable us to exchange information upon the many important questions connected with our business. To this end do we establish the following

CONSTITUTION.

ARTICLE I.

SECTION 1. The name and style of this Association shall be the AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION.

ARTICLE II.

SEC. 1. The officers of the Association shall be a President, a First and Second Vice-President, a Secretary, and a Treasurer.

SEC. 2. The above-named officers shall be elected separately, by ballot, at each Annual Convention, and a majority of all votes cast shall be necessary to a choice.

SEC. 3. Two tellers shall be appointed by the President to conduct the election and report the result.

ARTICLE III.

SEC. 1. It shall be the duty of the President to preside in the usual manner at all the meetings of the Association, and approve all bills against the Association for payment by the Treasurer.

SEC. 2. It shall be the duty of the Vice-Presidents, according to rank, to perform the duties of the President in his absence from the meetings of the Association.

SEC. 3. In case of the absence of both President and Vice-Presidents, the members present shall elect a President *pro tempore.*

SEC. 4. It shall be the duty of the Secretary to keep a full and correct record of all transactions at the meetings of the Association; to keep a record

of the names and places of residence of all members of the Association, and the name of the road they each represent; to receive and keep an account of all money paid to the Association, and at the close of each meeting deliver the same to the Treasurer, taking his receipt for the amount; to receive from the Treasurer all paid bills, giving him a receipted statement of the same.

SEC. 5. It shall be the duty of the Treasurer to receive all money from the Secretary belonging to the Association; to receive all bills against the Association, and pay the same, after having the approval of the President; to deliver all paid bills to the Secretary at the close of each meeting, taking a receipted statement of the same; to keep an accurate book account of all transactions pertaining to his office.

ARTICLE IV.

SEC. 1. The following persons may become members of the Association by signing the Constitution, or authorizing the President or Secretary of the Association to sign for them, and pay the initiation fee of one dollar: Any persons having charge of the Mechanical Department of a Railway known as "Superintendents," or "Master Mechanics," or "General Foremen," the names of the latter being presented by their superior officers for membership, also two Mechanical Engineers, or the representative of each Locomotive Establishment in America.

SEC. 2. Civil and Mechanical Engineers, and others whose qualifications and experience might be valuable to the Association, may become Associate Members by being recommended by three active members. Their names shall then be referred to a committee, which shall report to the Association on their fitness for such membership. Applicants to be elected by ballot at any regular meeting of the Association, and five dissenting votes shall reject. The number of Associate Members shall not exceed twenty. Associate Members shall be entitled to all the privileges of active members excepting that of voting.

SEC. 3. Any person who has been or may be duly qualified, and signs, or causes to be signed, the Constitution, as member of the Association, remains as such until his resignation may be voluntarily tendered.

SEC. 4. All members of the Association will be liable for such dues as may be necessary to assess to defray the expenses of the Association, and any member who shall be two years in arrears for annual dues shall have his name stricken from the roll, and be duly notified of the same by the Secretary.

ARTICLE V.

SEC. 1. The regular meeting of the Association shall be held annually on the third Tuesday in June.

SEC. 2. Regular meetings shall be held at such place as may be determined upon by a majority of the members present at the previous meeting.

SEC. 3. An adjourned meeting may be held at any time and place that a majority of the members present at any meeting may elect.

SEC. 4. The regular hours of sessions shall be from 9 o'clock A. M. to 2 o'clock P. M.

SEC. 5. During the business sessions no communications shall be received or acted upon other than those pertaining to the business of the Association.

SEC. 6. At this, the Thirteenth Annual Meeting, the President shall appoint three members to constitute a standing committee to recommend to the Association at each Annual Meeting subjects for discussion at each succeeding Convention, one member for three years, one for two years, and one for one year, designating the term of each member, and each succeeding year one member of said committee shall be elected by the Association by ballot.

The said committee shall, at one o'clock on the second day of each Annual Convention, report to the Association subjects for discussion at the succeeding Convention.

At 7:30 o'clock of the second day of each Annual Convention there shall be a joint meeting of said committee with an advisory committee, composed of the officers of the Association, which joint committee shall, at ten o'clock on the morning of the third day of each Annual Convention, nominate to the Association the members of the several committees upon said subjects. Said joint committee shall nominate, upon subjects which require reports, from various parts of the country, full committees of three or five, which committees shall be called committees of research, and shall have power to solicit reports from not all but a part of the members of the Association upon such subjects; and upon other subjects said joint committee shall nominate simply the chairman of the committees, who shall have power to select their own associates upon such committees, which shall be called committees of investigation; said joint committee shall also nominate two Associate Members to read papers at the succeeding Annual Meeting.

All committees so appointed, whether of research or investigation, shall meet at four o'clock on the afternoon of the third day of each Annual Convention to plan and divide its work for the ensuing year.

Each committee on research shall, on or before the first day of July of each year, send to the Secretary of the Association a circular letter setting forth the character of reports desired from the members, together with a list of persons to whom said letter shall be sent; and the Secretary shall immediately print and mail the same to such members, with an earnest request that, as a matter of courtesy, full replies thereto shall be sent on or before the first day of April following to the chairman of such committees.

Each committee, whether of research or of investigation, shall, if possible, meet pursuant to the call of its chairman, during the second week in April of each year, for the preparation of its report, which, in the absence of such meeting, shall be prepared by the chairman, and shall immediately forward the same to the Secretary of the Association, by whom it shall be printed and supplied to the members at the commencement of each Annual Convention.

Each report of such committees shall name the members of the Association from whom replies to said circular letters were requested but not received, on or before the first of April as aforesaid.

ARTICLE VI.

SEC. 1. This Constitution may be amended at any regular meeting of the Association by two-thirds vote of the members present.

Resolution Passed at the Sixth Annual Meeting, Baltimore, Maryland, May, 1873.

Resolved, That no expense shall be incurred by committees except by the unanimous consent of the General Supervisory Committee, given in writing to the Chairman of said Committee, stating the amount to be expended.

Resolution on Boston Fund, Passed at the Eighth Annual Meeting, New York, May, 1875.

Resolved, That the Boston Fund, amounting now, with accrued interest, to $3,620, be invested in Government securities to be selected by the duly appointed Trustees, and not to be disturbed for the purpose of expenditure unless authorized by the majority of members present in open Convention, and then only after due notice of a motion to expend the same has been given at the session immediately preceding; and that the interest accumulating shall every year be invested in the same manner as the principal, and a full account of the same be duly reported with other financial statements.

Resolution Adopted at the Ninth Annual Meeting.

Resolved, That members of the Association who have been in good standing for a period of not less than five years, and who through age or other cause cease to be actively engaged in the mechanical departments of railroad service, may, upon the unanimous vote of the Association, be elected "Honorary Members," who shall have their dues remitted and be entitled to all the privileges of regular members except that of voting.

ORDER OF BUSINESS.

1. Reading the Minutes of the previous meeting.
2. Calling the Roll of Members.
3. Signing the Constitution.
4. Report of Secretary.
5. Report of Treasurer.
6. Report of Committees appointed at a previous meeting.
7. Election of Officers.
8. Appointment of a Committee to suggest Subjects for Consideration.
9. Appointment of Miscellaneous Committees: Finance, Printing, and Place of Holding Next Annual Meeting.
10. Report of Committee to suggest Subjects for Consideration.
11. Appointment of Committees to report upon Subjects suggested for Consideration.
12. Unfinished Business.

R. WELLS,
JAMES SEDGLEY,
HOWARD FRY,
S. J. HAYES,
J. H. SETCHEL,
} *Committee.*

NAMES AND ADDRESS OF MEMBERS.

NAME.	ROAD.	ADDRESS.
Anderson, H.	204 Dearborn street	Chicago, Ill.
Anderson, J. H	N. Y., B. & P. Rd.	Providence, R. I.
Arden, D. D	C. & S. W. Rd. of G	Savannah, Ga.
Barton J. C	H. & C. W. Rd	Hartford, Conn.
Britton, H. M	N. Y., S. & W. Rd	New York City.
Boon, J. M	C. & N. W. & C. Rd	Chicago, Ill.
Bushnell, R. W	B., C. & R. N. Rd.	Cedar Rapids, Iowa
Brastow, L. C	C. Rd. of N. J	Wilkesbarre, Pa.
Boyden, G. E		Boston, Mass.
Brooks, H. G	Brooks Locomotive Works	Dunkirk, N. Y.
Barnett, J. Davis	Grand Trunk Rd	Montreal, Canada.
Black, John	C., H. & D. Rd	Lima, Ohio.
Blackall, R. C.	D. & H. C. Co	Albany, N. Y.
Bissett, John	C. & D. Rd	Florence, S. C.
Briggs, R. H	M. & O. Rd	Whistler, Ala.
Bradley, S. D.	G. R. & I. Rd.	Grand Rapids, Mich.
Brigham, L. L.	Passumpsic Rd.	Lydonville, Vt.
Brownell, F. G	B. & S. Rd	Burlington, Vt.
Bryan, H. S	C. & I. Rd.	Aurora, Ill.
Chapman, N. E	B. & O. Rd	Baltimore, Md.
Chapman, J. W	N. Y., L. E. & W. Rd	Hornellsville, N. Y.
Chapman, Thos. L	C. & O. Rd	Huntington, W. Va.
Cummings, S. M		Boston, Mass.
Coolidge, G. A	Fitchburg Rd	Charlestown, Mass.
Clark, David	L. V. Rd.	Hazleton, Pa.
Clark, Peter	N. Rd. of Canada	Toronto, Canada.
Cooper, H. L	L., E. & W. Rd	Lafayette, Ind.
Cook, James	Danforth & Cook's Locomotive Works	Paterson, N. J.
Cushing, George	N. P. Rd	St. Paul, Minn.
Crockett Jno. F	B., L. & N Rd	Boston, Mass.
Cory, Chas. H		Fostoria, Ohio.
Colburn, Richard	N. & W. Rd	Norwich, Conn.
Clifford, J. G	I. M. Rd	Paris, Ill.
Cook, John S	Georgia Rd	Augusta, Ga.
Cook, Allen	C. & E. I. Rd	Danville, Ill.

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NAME.	ROAD	ADDRESS.
Devine, J. F.	W. & W. Rd	Wilmington, N. C.
Dripps, W. A.	3324 Walnut street	Philadelphia, Pa.
Durgin, J. A.	Rhode Locomotive Works	Providence, R. I.
Domville, C. K.	G. W. Rd	Hamilton, Ont., Can.
Elliott, Henry		E. St. Louis, Ill.
Ellis, J. C.	Schenectady Locomotive Works,	Schenectady, N. Y.
Ellis, W. H.	P. & R. Rd	Catawissa, Pa.
Ennis, W. C.	N. Y., S. & M. Rd	Wortendyke, N. J.
Eckford, Jas.		Cincinnati, Ohio.
Eastman, A. G.	S. E. Rd	Richford, Vt.
Foss, J. M.	C. V. Rd	St. Albans, Vt.
Fry, Howard	N. Y., W. S. & B. Rd.	New York.
Flynn, J. H.	W. & A. Rd	Atlanta, Ga.
Fuller, William	N. Y., P. & O. Rd	Cleveland, Ohio.
Finlay, L.		Little Rock, Ark.
Foster, W. A.	W. & M. Div. F. Rd	Fitchburg, Mass.
Fowle, I. W.	C., C., C. & I. Rd	Delaware, Ohio.
Gordon, H. D.	P., W. & S. B. Rd	Wilmington, Del.
Graham, Chas.	L. & B. Rd	Kingston, Pa.
Gilson, Gregg D.	Capiopa Rd	Chili, S. A.
Gordon, James	Concord Rd	Concord, N. H.
Graham, J. S.	L. S. & M. S. Rd., Buffalo Div.	Buffalo, N. Y.
*Hayes, S. J.	Ill. Cent. Rd	Chicago, Ill.
Hollister, James D.	S., F. & W. Rd	Savannah, Ga.
Holloway, J. W.	C., Mt. V. & D. Rd	Akron, Ohio.
Ham, C. T.	Buffalo Steam Gauge Co	Rochester, N. Y.
Hewitt, John	M. P. Rd	St. Louis, Mo.
Haynes, O. A.	St. L. & I. M. Rd	Carondelet, Mo.
Hollister, C. W.	Valley Rd	Hartford, Conn.
Hodgman, S. A.	P., W. & B. Rd	Wilmington, Del.
Haggett, J. C.	D., A. V. & P. Rd.	Dunkirk, New York.
Hanson, C. F.	Gt. W. Rd. of Canada	London, Ontario.
Hackney, George	A., T & S. F. Rd	Topeka, Kansas.
Hackney, C.	A., T. & S. F. Rd	Topeka, Kansas.
Howson, N. W.	C. & R. Rd	Mt. Savage, Md.
Henney, Jno., Jr.	N. Y., N. H. & H. Rd	Hartford, Conn.
Henney, J. B.	W. C. Rd	Stevens Point, Wis.

*Died September 21st, 1882.

NAME.	ROAD.	ADDRESS.
Howe, Geo. E.	St. J. & L. C. Rd	St. Johnsbury, Vt.
Hovey, J. P	R. & P. Rd	Rochester, N. Y.
Horniblower, J. P	Government Rd	Queensland, Australia.
Ivanson, J		Cincinnati, Ohio.
Johann, Jacob	W. & C. L. Rd	Springfield, Ill.
Jacques, Richard	Capiopa Rd	Chili, S. A.
Johnson, J. B	A. C. Rd	Helena, Ark.
Johnson, F. W	Sp., J. & P. Rd	Springfield, Ohio.
Jeffery, E. T	I. C. Rd	Chicago, Ills.
Kent William	Shoenberger & Co	Pittsburgh, Pa.
Kinsey, J. I	L. V. Rd	Easton, Pa.
Keeler, Sanford	F. & P. M. Rd	East Saginaw, Mich.
Kilby, G. S	C. & P. Rd	Lyndonville, Vt.
Kaufholz, F. G	C., C., C. & I. Rd	Cleveland, Ohio.
King, Robert	W. & R. Rd	Montgomery, Ala.
Lannon, Wm	House of Representatives	Washington, D. C.
Losey, Jacob	Steam Forge Co	New Albany, Ind.
Lauder, J. N	N. Rd of N. H.	Concord, N. H.
Leech, H. L.	No. 1, Rollins street	Boston, Mass.
Lewis, W. H	D., L. & W. Rd	Kingsland, N. J.
Levis, J. M.	S. M. & M. Rd	Marion, Ala.
Mulligan, John	Connecticut River Rd	Springfield, Mass.
Mitchell, A	W. Div. L. V. Rd	Wilkesbarre, Pa.
Morse, G. F	Portland Locomotive Works.	Portland, Me.
Marten, John E	C., C. & T. Rd	Chili, S. A.
Maglenn, James	C. C. Rd	Laurinsburg, N. C.
McKenna, J	I., P. & C. Rd	Peru, Ind.
McFarland, John	C. & O. Rd	Richmond, Va.
McCrum, J. S	M. R., Ft. S. & G. Rd	Kansas City, Mo.
McVey, John		Chattanooga, Tenn.
McAlpine, A. B		Brightwood, Ind.
Miller, Wm. H	Transfer & Stock Yard Co	Indianapolis, Ind.
Minshall, E.	N. Y., O. & W. Rd	Middletown, N, Y.
Morrill, J. E	C., R. I. & P. Rd	Davenport, Iowa.
Ortton, John		St. Thomas, Canada.

NAME.	ROAD.	ADDRESS.
Pringle, R. M	St. L. & C. Rd	St. Louis, Mo.
Pendleton, M. M	S. & R. Rd	Portsmont, Va.
Perry, F. A	C. & A. Rd	Keene, N. H.
Perrin, P. J	Taunton Locomotive Works	Taunton, Mass.
Peddle, C. R	T. H. & I. Rd	Terre Haute, Ind.
Prescott, G. H	T. H. & I. Rd	Terre Haute, Ind.
Philbrick, J. W		Waterville, Me.
Prescott, G. W	C. & St. L. Rd	St. Louis, Mo.
Purves, T. B	W. Div. B. & A. Rd	Greensburg, N. Y.
Place, T. W	Ill. Cent. Rd	Waterloo, Iowa.
Pillsbury, Amos	Eastern Rd	Boston, Mass.
Pilson, S. S		Louisville, Ky.
Patterson, J. S	C. I., St. L. & C. Rd	Cincinnati, O.
Parry, Chas. T	Baldwin Locomotive Works	Philadelphia, Pa.
Player, John	Central of Iowa	Marshalltown, Iowa.
Porter, J. S	I., B. & W. Rd	Sandusky, O.
Ransom, Thos. W	I. & St. Louis Rd	Mattoon, Ill.
Richards, Geo	B. & P. Rd	Boston, Mass.
Robb, W. D	L. P. & S. M. Rd	Elizabethtown, Ky.
Reynolds, G. W	O. C. Rd., (N. Div.)	Taunton, Mass.
Robertson, Thomas	M. P. & C. Rd	Marietta, O.
Ross, Geo. B	N. Y., L. E. & W. Rd	Buffalo, N. Y.
Sellers, Morris		Chicago, Ill.
Schaeffer, August		Chicago, Ill.
Schlacks, Henry	I. C. Rd	Chicago, Ill.
Smith, Allison	Government Rd	New Zealand.
Smith W. T	P. & E. Rd	Erie, Pa.
Strode James	E. & C. Div., N. C. Rd	Elmira, N. Y.
Stearns, W. H	Connecticut Rd	Springfield, Mass.
Shaver, D. O	Pennsylvania Rd	Pittsburgh, Pa.
Setchel, J. H	O. & M. Rd	Cincinnati, O.
Sedgley, James	L. S. & M. S. Rd	Cleveland, O.
Sanborn, A. J		Mattoon, Ill.
Stevens, G. W	L. S. & M. S. Rd	Elkhart, Ind.
Sprague, H. N	E. K. Porter & Co	Pittsburgh, Pa.
Salisbury L. B	St. L. & S. E. Rd	Mt. Vernon, Ill.
Selby, W. H	St. L., K. C. & N. Rd	Moberly, Mo.
Simonds, G. B	C. & St. L. Rd	East Carondelet, Ill.
Sitton, B. J	S. R. & D. Rd	Selma, Ala.

NAME.	ROAD.	ADDRESS.
Swantson, Wm.	J. M. & I. Rd	Jeffersonville, Ind.
Steel, W. J	L. N. & Gt. S. Rd	Nashville, Tenn.
Stone, Henry B.	Supt. Locomotive and Car Dept. C., B. & Q. Rd	Chicago, Ill.
Short, Will A.	Canada Southern Rd	St. Thomas, Ont., Can.
Twombly, T. B.	C. R., I. & P. Rd	Chicago, Ill.
Turreff, W. F	C., C., C. & I. Rd	Cleveland, O.
Towne, H. A		Brainerd, Minn.
Taylor, J. K	O. C. Rd	Boston, Mass.
Tull, C. H.		Monroe, La.
Thumser, John	O. & M. Rd	Seymour, Ind.
Thomas, W. H.	N. & D. Div. L. & N. Rd	Nashville, Tenn.
Thaw, William	S. A. Rd	Adelaide, S. Australia.
Underhill, A. B.	B. & A. Rd	Springfield, Mass.
Van Vetchen, J	N. Y., L. E. & W	Susquehanna, Pa.
Watrows, Geo. C	D., L. & N. Rd	Iona, Mich
West, Geo. W	S. C. & N. Y. Rd	Syracuse, N. Y.
Walsh, Thomas	L. & N. Rd	Mt. Vernon, Ill.
West, Thomas	N. Y., L. E. & W. Rd	Buffalo, N. Y.
Warren, B	St. L., A. & T. H. Rd	St. Louis, Mo.
Wells, Reuben	L. & N. Rd	Louisville, Ky.
Wiggins, J. E		
Woodcock, W	Central Rd. of N. J	Elizabethport, N. J.
White, J. L		Evansville, Ind.
Williams, E. H	Baldwin Locomotive Works	Philadelphia, Pa.
Weaver, D. L	E. K. Rd	Hunnewell, Ky.
White, Phillip		Wellsville, O.
Wilder, F. M	N. Y., L E. & W. Rd	Susquehanna, Pa.
Wightman, D. A	Pittsburgh Locomotive Works	Pittsburgh, Pa.
Wright, John W		
Warren, W. B	O. & S. Rd	Springfield, O.
White, C. W	L. & N Rd	Birmingham, Ala.
Young, L. S		Cleveland, O.

ASSOCIATE MEMBERS.

NAME.	ROAD.	ADDRESS.
Dean, F. W	Matthews Hall	Cambridge, Mass.
Evans, W. W	Sans Souci, near New Rochelle,	New York City.
Forney, M. N	73 Broadway	New York City.
Gordon, Alex	Niles Tool Works	Hamilton, O.
Hill, John W		Cincinnati, O.
Lilly, J. O. D		Indianapolis, Ind.
Lyne, Lewis F	M. E., 96 Fulton street	New York City.
Miles, F. B		Philadelphia, Pa.
Morten, Henry	Professor, Stevens' Institute	Hoboken, N. J.
Raymond, J. H	Western R. R. Association	Chicago, Ill.
Sellers, Coleman		Philadelphia, Pa.
Smith, Chas. A	Washington University	St. Louis, Mo.
Smith, Willard A	Chicago Review	Chicago, Ill.
Thurston, R. H	Professor, Stevens' Institute	Hoboken, N. J.
Wheelock, Jerome		Worcester, Mass.

HONORARY MEMBERS.

Dripps, Isaac	3405 Walnut Street	Philadelphia, Pa.
Robinson, W. A		Hamilton, Canada.

IN MEMORIAM.

Alexander L. Holley.

The death of ALEXANDER L. HOLLEY has created a profound sense of regret in all circles of society. He was so prominent in the scientific, mechanical and social world, a member of so many clubs, scientific and mechanical organizations, and so many memorial addresses have been made, recounting his praises, as to leave it difficult for a committee to speak of any virtue in a character so well and widely known that has not already been told.

Mr. Holley was for many years an Associate Member and an ardent supporter of the Master Mechanics' Association to which he has contributed a number of valuable papers.

The Secretary is indebted to the "Engineering and Mining Journal" for the following extracts of his life, taken from a memorial address, by R. W. Raymond, at the Club Theater, November 1st, 1882. Mr. Raymond said:

"Mr. Holley was born at Lakeville, in Salisbury, Connecticut, on the 20th of July, 1832. His father, Alexander H. Holley, subsequently Governor of the State, was a native of the same village. His mother, whose maiden name was Jane M. Lyman, was one of the Lymans of Goshen. The experts in New England genealogies will not need to be told that, on both sides, he came of good stock—such as, by a combination of enterprise, intelligence, and high principle, has made New England great. The mother could, indeed, bestow upon her son nothing more than the legacy of inherited character, for she died a few weeks after his birth; but her place was supplied by the second marriage of his father, three years later, to Miss Marcia Coffing, whose affection, bestowed freely upon her stepson through twenty years, was as freely returned by him. Their correspondence, some of which has been preserved, shows that their personal intercourse was intimate, and that this excellent lady,

though burdened with the cares of a lårge and hospitable household, never forgot to be a true mother to this son of her adoption, as well as to the children born of her. No doubt he was much indebted for noble impulses and principles to the influence of this devoted woman.

"For two or three years of his early boyhood he attended the district school near his father's house, and was then advanced to the academy, to which he walked, a little more than a mile and a half, every day, winter and summer. In later life he was accustomed to allude to this regular exercise as having laid the foundation of the fine constitution which enabled him for so many years to work so hard and yet so easily.

"From the academy in Salisbury he went to another, under the care of Mr. Simeon Hart, at Farmington, Connecticut, and after a year or more to Williams Academy, then directed by Mr. E W. B. Canning, at Stockbridge, Massachusetts. From Stockbridge he went to Bridgeport, Connecticut, to prepare for Yale College, under Rev. Henry Jones. According to the dates and internal evidence of his boyish letters the above order is not strictly correct. I find him at Stockbridge in 1846 and 1847, at Farmington in 1848, at Bridgeport in 1849, and back at Stockbridge in 1850. For our present purpose the question is not important, except as it shows an early trait in his character—a restlessness, born of versatility and genius, which under less judicious training might have wasted his life."

Mr. Raymond's address is very lengthy, and covers minutely Mr. Holley's career from early boyhood; but the following closing remarks of his address are a fitting tribute to the close of his useful life:

"We may answer now the question with which we began. This life *was* successful. It was filled with the joy of labor; it was surrounded at the last with comfort and fame and troops of friends. But the success was not of accident, or luck, or sudden growth. It was earned inch by inch; won out of innumerable delays and defeats; held at the cost of constant vigilance and toil. Homer sings of warriors who were invulnerable and irresistible; but Homer gives them the assistance of the gods, fighting invisibly beside them; and

to my mind his noblest heroes are those who stand up bravely against such odds, and die where they stand. Again, the tales of chivalry are full of triumphant champions, whose lances in *melee* or tourney nothing can resist. But history tells us that, apart from the exaggerations of the legend, these all-conquering heroes were arrant humbugs—princes whose prowess it was the part of courtiers to help them to exhibit; that their invariable triumph was the farce of hired players. *Our* hero was no such gay cavalier. Neither miracle nor connivance made his lance omnipotent. His armor was bruised and dented in earnest; he knew the shock, the overthrow, the retreat, the struggle again and again renewed, the victory that called for new conflicts with new risk of defeat.

"If Holley's genius was such as to forbid us from hoping, by mere effort, to attain equal heights, yet on the other hand, there is ample encouragement and instruction in his career for all young engineers. Let me, in closing, barely mention its chief lessons.

"The first is the great benefit of uniting theory and practice. It is less important how these are to be combined than that the student of either should not despise the other. Every word that Holley spoke, every line he wrote, betrayed his familiarity with the practical operations, tools, difficulties and needs of his business. A great inventor once said to me (when I talked to him of some fancied discovery of my own): 'My boy, half the art of invention consists in knowing what needs to be invented.' Holley's career illustrates this principle, and bears witness also how deeply he felt what he called the inadequate union of engineering science and art, and how ardently he labored to make it closer and more complete. Not his eloquent words merely, but the eloquence of his whole life speaks one language—the language of the brotherhood of brain-workers and hand-workers. And what he was, even more than what he said or did to promote such union, wrought mightily to that great end. For the end is to be found in the multiplication of such men as he—men who do not merely preach harmony to the two classes, but actually belong to both.

"It is important to observe that the foundation of his training was wholly American. Far be it from me to disparage the advantages of foreign study. I would not speak such treason to my own alma mater in a far land. But I say, without hesitation, that he

brings most from travel and study abroad who carries most to them. Many a precious graft they have furnished and will yet furnish to our native stock; but the stock is as important as the shoot, and there are too many young men returning with their hands full of scions and nothing to graft them on. How illustriously different was Holley's career.

"Another important matter is the early cultivation of the observing powers, and, as incidental thereto, the art of drawing. Holley's facility in these respects was an inestimable advantage to him. He inclined to graphic methods of stating and solving engineering problems; and his eye, thus trained, became an intuitive judge and calculator.

"Then comes, in natural succession, the habit of instant, rapid, accurate, methodical recording of observations. It was Holley's practice to do this constantly; to make every record so clear and complete that it could be comprehended and used after years had passed; and to index his note books and scrap books so that they became thoroughly available at any moment. This is no trifling matter. When the officers of our corps of engineers are examined as to their fitness for promotion, they are obliged not only to answer questions and prepare 'projects,' but also to exhibit the note books they have kept during their terms of service. No other revelation of character is more significant, no test more severe. The work that a man does in a hurry and unobserved, and for himself, not the public, tells the story of his method and temperament. Holley's note books are models of fullness and order.

"But neither observing, nor recording, nor studying, nor the combination of all these with practical training completely furnish the engineer for the highest place; for he has to deal not merely with matter and mathematics but also with men. They must be made to recognize his skill, to back his enterprise, to co-operate in his achievements. Influence, *influence*—that is the secret of power. Genius may seize opportunities; influence brings them. And the chief vehicle of influence is language. The mastery of language, therefore, is no superfluous accomplishment to the engineer. The young man who deliberately and of choice says, 'I mean to be scientific but not 'literary;'' or the parent who says, 'My boy is not going to need a liberal culture, he is going to be an engineer,'

is ignorant of the most potent principle of modern life—the solidarity of the race, the dependence of each upon all, the necessity of a wide foundation for a high fame, the universal law that every occupation deals ultimately with men even more than with things, and that the ability to shape things is almost barren without the power to move men.

"But language, as the means of this power, is effective in proportion as it is filled with appeals to the responsive associations of human minds. A host of things in fancy, poetry, history and general literature, concerning which people are interested, may be trivial in themselves, it is nevertheless worth while to know them and to use them as a means of commanding the interest and assent of men. In other words, a wide culture, in sympathy with the age in which we live, is an element of power. It is true that all this, belonging to the art of expression, is wasted in the hands of him who has nothing to express. Men may be arrested to listen, but they will soon find out that behind the skillful utterance there is neither character nor knowledge. They may be fascinated by the instrument until they find out there is nothing in the tune. But when real genius and noble ambition utter themselves through the channels of art in language, how gladly hears the world!

"Holley's versatility and intellectual sympathy with many lines of thought prevented him from sinking to the level of drudgery, though he worked harder than many a drudge; they made him not merely a bricklayer but an architect for his generation. Controlled and reinforced by a mighty perseverance, softened and brightened by an unfailing gentleness of soul, they added to his genius that which made him great. For what we call greatness in any sphere is simply *recognized excellence.* The excellence may be spurious, the recognition may be factitious and ephemeral—then the greatness is false, and the great of to-day are forgotten to-morrow. But when a noble character has been nobly exhibited; when genuine power has won genuine praise; when fame soars not for a brief flight into the windy air, but stands firm-footed on the solid pyramid of achievement, to sound through her silver trump the name of her victorious son—conqueror of nature, leader of men—this greatness will endure.

"Build him a monument that shall testify our love and his renown. Let the world understand that not alone the plots of politics or the

luck of war may give title to such public memorials. This witness, addressing as it does the imagination, the ambition, the worthy pride of the greatest number of men, is conspicuously appropriate to a life so many-sided and complete, so simple and sincere, yet so popular and influential.

"He did not, as once he feared he might, go down poor and unknown, carrying with him thoughts of which the world was not worthy. He was heard, believed, accepted, rewarded—with no greater delay or difficulty than sufficed to bring out to their full extent his own best powers. It was given to him to do grand things in the sight of all men; and beneath all our words and pictures and statues of him lies forever a sure foundation—the work that he did for his time.

"Foresters tell us that a tree once marked will retain the mark, though a hundred years of growth may have overlaid it with later coverings. What may be the future spread and stature of the stately oak of American engineering we can not presume to foretell; but there will come no time when the historian, stripping off the rugged bark and cutting through the rings of many generations, will not find at the heart that name which with keen blade and skillful hand was carved by Alexander Lyman Holley!"

William Rushton.

Died Thursday morning, November 24th, 1881, of apoplexy, Mr. WILLIAM RUSHTON, at his home in Atlanta, Georgia. He was born in Manchester, England, August 18th, 1818, and came to America, with his father's family, when only ten years old, landing in Philadelphia, where his boyhood days were passed, and where in the works of Mr. Large he served an apprenticeship of seven years.

In 1846 he came South to take a position in the Georgia Railroad shops, at Augusta, Georgia. Four years later he was made Master Mechanic of the same road, with head-quarters in Atlanta, Georgia, which position he held until his death, a period of thirty-three years.

He was a noted man in many respects; chief of which was his sterling character and his unswerving integrity; he was devoted to his profession. A kind and affectionate husband, a loving father, and

above all a Christian, dying in the full hope and faith that when the body goes back to the dust from whence it came the soul would dwell in immortality with God who created it.

By his superiors in office he was highly respected and esteemed, not only for his personal worth but for the high order of his mechanical mind; and by his employees he was beloved and revered with almost the affection due a father. By his death the Association has met with a loss that will be deeply felt by all its members.

JOHN H. FLYNN,
JAMES MAGLENN, } *Committee.*
R. H. BRIGGS,

H. E. Woods.

The Committee appointed to take action on the death of H. E. WOODS would report as follows:

During the past year one of our members, H. E. Woods, has died. Mr. Woods took charge of the round house at Rock Island, on the C., R. I. & P. R. R., in 1857. He left there in 1878 to take the position of Master Mechanic on the Davenport & St. Paul Railroad, which position he held until the road was sold to the C., R. I. & P. R. R., when he went to Colorado, where he died.

He was a good mechanic, a fine executive officer, and morally and socially all that could be wished.

The Committee would offer the following:

WHEREAS, Death has taken from us our late associate, H. E. Woods; by his death this Association has lost a valued and respected member, and society a useful citizen; therefore be it

Resolved, That we tender to his family our sympathy in their bereavement, and further

Resolved, That a copy of these resolutions be spread on the records of the Association, and that the Secretary be directed to send a copy to the family of the deceased.

JAMES M. BOON,
T. B. TWOMBLY, } *Committee.*
JACOB JOHANN,

William S. Hudson.

The death of WILLIAM S. HUDSON occurred at his residence at Haledon, a beautiful suburb of Paterson, N. J , on the night of July 20, 1881. He was 72 years of age at the time of his death.

He was born near the town of Derby, England, in 1809, and at an early age began to learn the trade of an engineer and machininst, serving part of his apprenticeship under George Stephenson. In 1833, when 24 years of age, he came to this country, and for a time found work in the engine room and machine shops attached to the Auburn State Prison in New York. He soon left that place, however, and engaged as a locomotive runner on the old Rochester & Auburn Railroad, now a part of the New York Central. Subsequently he ran an engine on the Attica & Buffalo Railroad, and was made Master Mechanic of the road, which he left in 1852 to become Superintendent of the locomotive works of Rogers, Ketchum & Grosvenor, at Paterson, N. J. In 1856 these works were incorporated as the Rogers Locomotive & Machine Works, and Mr. Hudson was made Mechanical Engineer and Superintendent, a position which he held until his death. He succeeded Mr. Thomas Rogers, who was the founder of these works, and who probably did more than any other man to develop the design and improve the construction of the American engine as it is to-day. But Mr. Hudson took up the work where Mr. Rogers left it, and during the thirty years that Mr. Hudson occupied the position of the head of the mechanical department of this establishment, he made many improvements in the locomotives built there, chiefly of a kind which are the result of simplifying details, adopting better methods of putting work together, and making the engines more substantial and more serviceable. He studied, as probably no other locomotive builder did, the performance of the engines he built. He was constantly looking out for their weak points, and it was said by the present head of the establishment that Mr. Hudson was always more concerned about building a *good engine* than he was in making a *good profit*.

He was a very watchful superintendent, and was constantly looking after the minute details in the shops and seeing that the tools,

machinery, the material, the processes and the men were suited
ie purpose for which they were employed.

ut while most of Mr. Hudson's time was devoted to improving
construction of the locomotives built in the shops which he su-
intended, he also had a great love for original investigation and
a prolific inventor.

n 1861 he patented a process for welding an upper thick section
lower thinner part of a tube sheet.

n 1865 he took out a patent for operating safety valves.

n 1867 a patent was granted to him for a locomotive with a sin-
axle, or half truck, at each end, and with two pairs of driving
els between them. The advantages set forth in the patent for
engine were, first, that it would run equally well with either
foremost; second, that the load was equalized between the rear
ing wheels and the rear truck, and the front driving wheels and
front truck, the truck wheels at the same time being free to move
rally. A number of these engines were afterward built with
s on top of the boiler.

n July 16, 1872, six patents were granted to him for improve-
ts in tank locomotives. The patents covered three types of
ne, all with outside cylinders and with frames extended back of
fire box to carry a water tank behind. One type had two pairs
riving wheels, all located between the smoke box and fire box,
with a half or Bissel truck in front of the cylinder and a four-
eled truck behind the fire box. The second type had, besides
ank behind, two side tanks alongside the boiler, and three pairs
riving wheels, two between the fire box and smoke box and the
r pair behind the fire box. It had a half truck in front of the
nders and another similar to it under the tank and extended
nes behind. In the third type of engine not only were the
d frames extended behind the fire box, but they were also car-
forward in front of the smoke box, and a water tank was
ried on the extensions of the frames at each end of the engine.
ere were no side tanks on this engine.

It had three pairs of driving wheels, all located between the fire box
d smoke box, and had two four-wheeled trucks, one under the
tended frames in front of the cylinders and the other behind the
e box. The king bolts of the trucks of these engines all had
ateral motion" and an elaborate system of equalizing levers was

His mind naturally seemed to aim at utility in the design of machinery, and he seemed to pay little regard to grace or beauty for their sake alone. He had little patience with carelessness or dullness, and enjoyed original research more than anything else; or, as one of his assistants expressed it, "When he was investigating any subject he was in his pleasantest moods."

The members of the Master Mechanics' Association had abundant opportunity to judge of the gentleness and modesty of his disposition, and withal, the annual records of the Association bear ample testimony, in the reports of the discussions in which he took part, of the clear, strong and vigorous character of his thinking and speaking. Any one listening to his conversation, either in private or public, would always be struck with the impartiality and reasonableness of what he said.

Although he achieved a very considerable measure of wordly success, no one well acquainted with him could help seeing that his whole character was tinged with a sadness which was inexpressibly touching to them who knew its cause. He had three daughters, only one of whom is now living, and one son. During the war this son volunteered and entered the army and was severely wounded. Although he recovered temporarily, the injury to his constitution was lasting, and finally caused his death. This great sorrow left the father's life surrounded with a haze of sadness which lasted till his death.

To the Master Mechanics' Association his loss is irreparable, and it is literally true of it, as it is of many of his friends, that any other man could have been spared better than he. His life was an illustration of that true nobility of character which is self-made, and which is developed when the gates which lead to advancement from the ranks are left open. No adventitious circumstances, such as birth, wealth or scholastic technical education aided him. He made his own career by his industry, integrity and energy, combined with an insatiable appetite — it may be called — for knowledge. His life is a good example for young men, its history is an encouragement to those of middle age, and to the old it is an illustration of how a useful life may be lived and how, when it is ended, its memory will be honored and loved.

M. N. FORNEY.

William Spittle,

Late Master Mechanic of the Valley Railway, was born at Pontipool, England, April 6th, 1831, and died at Cleveland, August 5th, 1881.

Mr. SPITTLE came to the United States with his parents in 1836, and settled at Pittsburgh, Pa. They removed to Sandusky, Ohio, in 1847, where William was apprenticed to what was then known as the Mad River Railroad in the year 1850, being then 19 years of age; he remained with that company thirteen years, and was then placed in charge of their shops at Dayton. At the end of three years he removed to Cleveland and accepted the position of engine dispatcher and round house foreman of Mahoning Division A. & G. W. Railroad, under F. C. Ford, Master Mechanic; at the end of five years he returned to Dayton to take charge of the Dayton & Southeastern Railroad; from there he returned to Cleveland as engineer in Otis Iron and Steel Works and resigned to accept a situation on the Valley Railroad, as Master Mechanic, and afterward returned to the Otis Iron and Steel Works, as engineer, where he was employed at the time of accident which caused his death.

At time of accident he was going to the hospital to visit an employee of the steel works, who had been injured. In crossing the L. S. & M. S. R. R. main track he saw the fast mail train approaching him and stepped hurridly on the side track; the escaping steam from the passing mail train preventing him from seeing a switch engine which was rapidly approaching on side track, he was knocked down and dragged some distance before the engine was stopped.

When picked up he was unconscious, and not being recognized by any person present, was carried to the hospital, where he lay from 6 P. M. Sunday until 11 P. M. same day, when death relieved him.

Mr. Spittle was a very faithful and efficient man and officer, and was highly appreciated by his superior officers, and beloved by his friends and employees.

Respectfully submitted,

W. F. TURREFF,
WM. FULLER,
G. W. STEVENS, } *Committee.*

INDEX.

THE NEXT ANNUAL CONVENTION

will be held on the third Tuesday in June, 1889,

IN CHICAGO, ILL.

Committee of Arrangements.

E. T. JEFFERY, Illinois Central R. R.

JACOB JOHANN, Wabash & St. Louis R. R.

J. M. BOON, Chicago & North-western R'y.

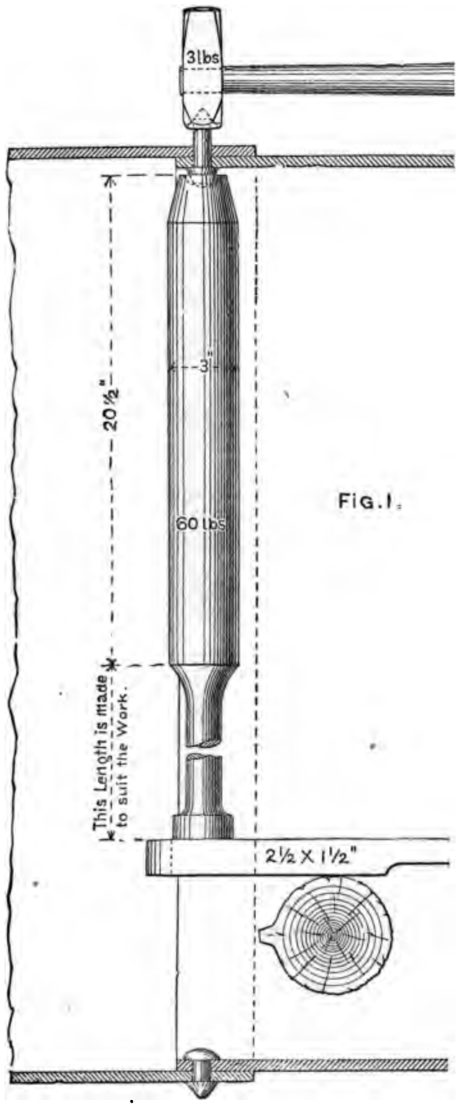
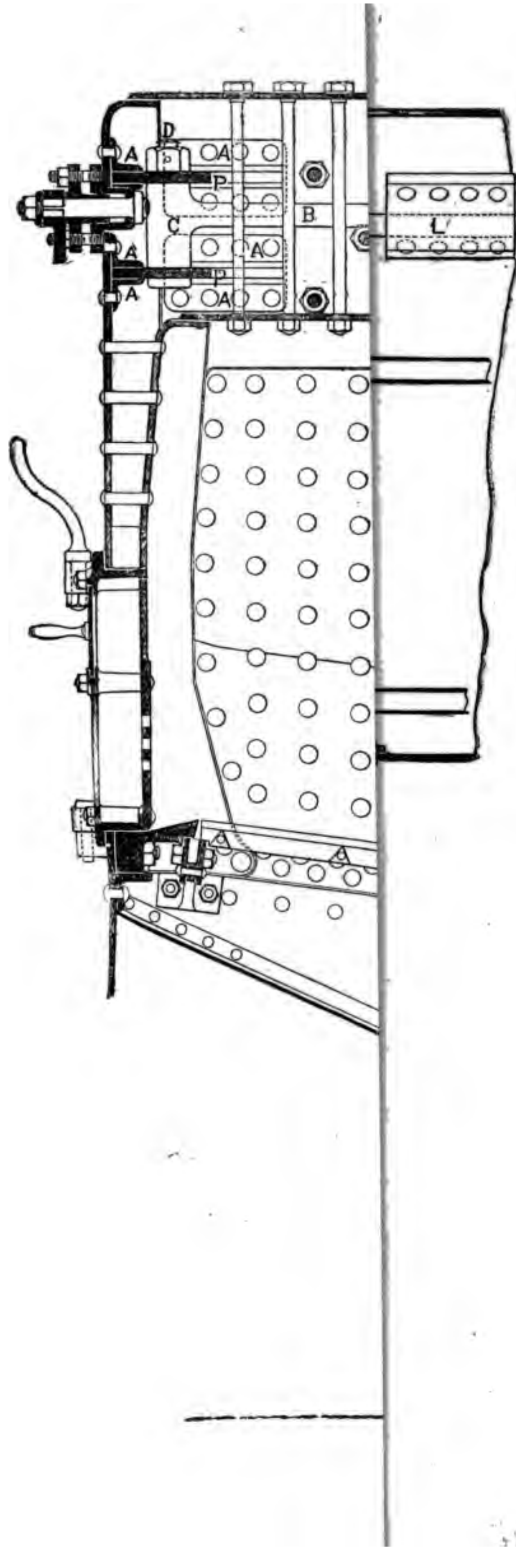


FIG. I.



D
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Belpair Boiler.

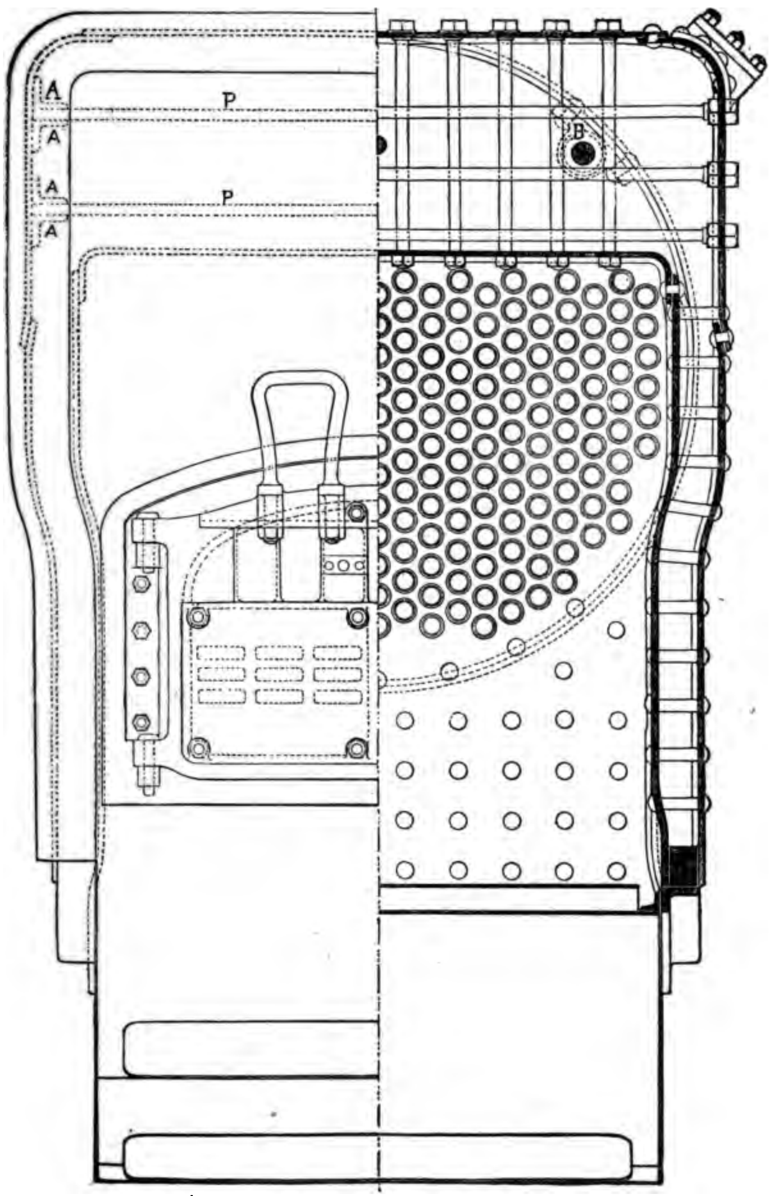
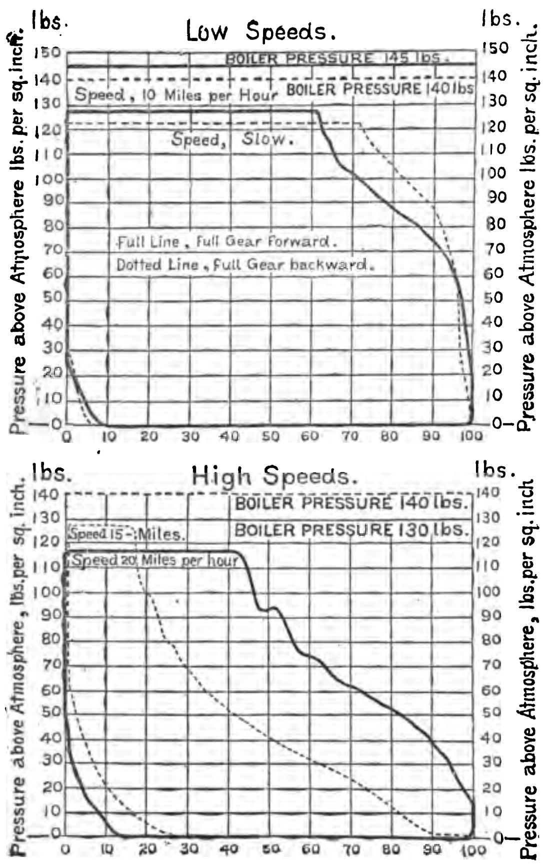


FIG. 196.



Joy's Valve Gear.